MODELLING AND ASSESSMENT OF SICKNESS IN THE ORGANIZED SECTOR OF COTTON TEXTILE INDUSTRY

A Thesis Submitted
In Partial Fulfilment of the Requirements
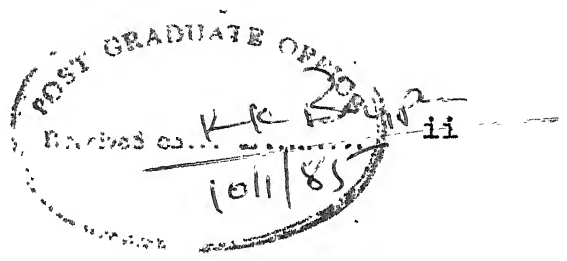for the Degree of
DOCTOR OF PHILOSOPHY

By

MOHAMMAD WASIM ABBAS

to the

INDUSTRIAL AND MANAGEMENT ENGINEERING PROGRAMME
INDIAN INSTITUTE OF TECHNOLOGY, KANPUR
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CERTIFICATE

Certified that the work entitled "MODELLING AND ASSESSMENT OF SICKNESS IN THE ORGANIZED SECTOR OF COTTON TEXTILE INDUSTRY" has been carried out by Mr. Mohammad Wasim Abbas under my supervision and has not been submitted elsewhere for the award of a degree.

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I dedicate this thesis to my Late father.

January 1985   M. Wasim Abbas

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SYNOPSIS

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Indian cotton textile industry is one of the largest industrial sectors in the country. It contributes about 20% to the national production. In the country's industrial scenario this sector also occupies a dominant position in terms of deployment of men, machines, materials and money. However, due to stiff competition with non-organized handloom and powerloom sectors of the industry and due to multitude of other reasons like high raw material cost, outmoded machinery and varacious government policies, the organized mill sector of the industry is facing the phenomenon of sickness. This has resulted in the closure of several mills

as well as governmental take-over in many cases. In 1980
there were a total of 691 cotton textile mills in the
organized sector, including 116 mills under the government
control. The Reserve Bank of India (RBI) reported that in
December 1979 there were 88 sick mills with a blocked capital
of Rs.3088.6 million. This figure excludes the mills taken
over by the government.

The organized mill sector of the industry involves
large commitment of resources by the promoters, financial
institutions, depositors, shareholders, creditors, etc. It
provides livelihood and employment to a sizeable section of
the society. The sickness at the unit level as well as at
the level of industry culminates into various types of socio-
economic problems. In a developing economy where scarcity
of resources, social welfare and need for steady economic
growth are pressing problems, the governmental regulation of
certain vital industrial sectors plays an important role and
is a well accepted phenomenon. Keeping in view the significance
of the textile sector in the Indian socio-economic framework,
various financial institutions in the country under the
aegies of the Reserve Bank of India have formulated
rehabilitation and reconstruction programmes to take care
of financial problems of sick textile mills. Under these
programmes the sick mills receive soft loans to rehabilitate

themselves. The mills which are beyond redemption are generally taken over by the government and managed by the National Textile Corporation (NTC) or respective State Textile Corporations (STC's).

The assessment of industrial sickness is a complex task, since cognizing the health status of an organization requires identification of a number of factors and processing of a large volume of data rudimenting from a variety of performance aspects. In the literature, multiple definitions of the term 'Sickness' are available. Each definition considers the problem of sickness from one particular view point. Each of these definitions, upon application, can result in the identification of a different sets of sick mills in the industry. However, keeping the complexity of the problem in view, more often than not, the financial institutions decide upon the health status of an industrial unit simply based on financial aspects. Even based on financial aspects, there are a variety of definitions for the term "sickness". These definitions stem from the use of different financial norms, viz., erosion of equity, generation of surplus liquidity and solvency position, the amount and period of irregularities in payments etc. The definition of sickness provided by RBI calls for a loss or expected loss during the previous, present and the coming

financial years with current liabilities to assets ratio
greater than one. Various banks and financial institutions
generally use RBI norms to decide upon the health status
of a unit and its fitness for rehabilitation programme. The
sickness norms set up by RBI seem to be too general and
vague. Occasionally their application results in indecisions
and conflicts in the process of decision-making as well as
in the assessment of health status of a mill. No attempt
seems to have been made to answer the question: how sick
is a sick unit in the relative domain of the industry? An
idea on the relative health status of a mill would help the
financial institutions to deploy the scare financial resources
year-marked for rehabilitation and nursing in a much more
rational fashion. Further, how far is it justifiable to
simply assess the health status of a textile mill based on
financial norms of profitability, etc., only when in reality
the health status of an organization is the final outcome
of several interacting elements steming from financial,
production, personnel, marketing and other aspects of
management. As such any attempt to classify a mill healthy
or sick simply based on one aspect can lead to erroneous
conclusions. A survey of the literature suggested that no
significant attempt has been made to establish a unitary
measure which could encompass more than one functional

aspect for the assessment of health status of a mill.

The problem of sickness assessment in a cotton textile mill calls for a systematic and in-depth study on different perspectives of the organized sector of cotton textile industry in order to identify the contributing elements and their interactions. Further, short-term as well as long-term performance indicators need to be identified. These will lay the foundation for developing a unitary scoring system for the health status assessment and comparing the mills in a comparative parlance. To that purpose, a multi-disciplinary approach which draws upon the framework of systems engineering, normative financial theory, and multi-variate statistical techniques has been adopted.

The scope of this research work can broadly be divided into three phases. The first phase is concerned with the descriptive as well as structural modelling aspects of the problem of sickness in cotton textile industry. The economic implications and significance of the problem of sickness have been highlighted by portraying a general scenario of the textile industry. Next, genesis of the problem has been reviewed surveying a large volume of literature available on the topic. The problem has been comprehended and explained through several causal elements. An Influence Digraph (ID) has been constructed using 31

interacting elements -- 28 of which are symptomatic
indicators of the sickness phenomenon and the remaining
3 stand for sickness, closure and takeover action. The ID
has been analyzed for identifying the hierarchical structure
of the causal system and the results have been portrayed
in the form of an Interpretive-Structural-Model (ISM). The
ISM is analyzed to obtain relative contextual significance
of each element in terms of its responsiveness to control.

In the second phase of the work, we attempt to
identify the short-term and long-term performance attributes
of a cotton textile mill. The ISM developed in the first
phase has been advantageously used to interact with the
"field practitioners". A set of 14 attributes which reflect
the short-term performance and encompass financial, economic,
physical utilization of facilities and productive efficiency
aspects concerning the mills, have been identified. A
random sample of 75 textile mills has been selected from
the 691 mills in the industry. The mills under the control
of NTC and STC were excluded for the purpose of sampling.
The sample comprised of 42 composite and 33 spinning mills.
The time series behaviour of the sampled mills with respect
to each of the 14 attributes has been observed to draw
inferences regarding the behaviour of the industry during
the period April 1971 - March 1981. The data on various
attributes for the sampled mills over a period of 10 years

are condensed in terms of traits using the Varimax Rotation Technique of Factor Analysis. A set of five factors, which are the hypothetical constructs or surrogates, representing the influence of short-term attributes are identified. These factors, F_1, F_2, F_3, F_4 and F_5, account for 73.4% of the total variation associated with the various attributes. Another surrogate called the Weighted Short-term Performance Surrogate (WSPS) is developed by assigning weights to each factor in proportion to the total variation explained by it. Next, the mill is treated as a business system and its long-term performance is evaluated in terms of Risk Coefficient (R_1), Stability Coefficient (R_2) and Resilience Coefficient (R_3).

The last phase of the present study considers several combinations of the short-term and long-term performance surrogates of a mill with a view to develop a unitary performance indicator. In all 19 combinations are considered. Discriminant Analysis has been used to develop a discriminant function which best classifies a set of well established sick and healthy mills into their respective classes. To this end, a sample of 17 mills (10 healthy and 7 sick mills) has been selected. It is observed that the short-term surrogates F_1, F_2, F_3, F_4, and F_5, when considered separately, classify only 60%

of the known cases correctly. Similarly, the long-term

surrogates, R_1, R_2 and R_3 alone have .76 probability of

correctly classifying a mill. The combination of WSPS with

R_1, R_2, R_3, too, missclassifies about 15% of the known

cases. The best set of discriminating variables are found

to be F_1, F_2, F_3, F_4, F_5, R_1, R_2, and R_3 with a probability

of correctly classifying a mill as high as 1.

A cut-off value 0.138 of the discriminant score,

Y, is identified. The mills with Y, less than this value

are declared healthy while the ones with Y exceeding the

cut-off value are branded sick. The Y-scores of all the

sampled mills for the year 1980-81 have been evaluated to

establish their health status on a unitary scale.

CHAPTER I

INTRODUCTION

1.1. The Industrial Sickness in India

The phenomenon of sickness is well known in the
Indian industries. In early sixties, the incidence of
sickness was mainly confined to cotton and jute industries.
However, the malady has now crept into other traditional
industries like cement and sugar, on one hand, and the
relatively modern industries like light and heavy engineering
(both electrical and non-electrical), chemicals, iron and
steel, basic metals, rubber, etc., on the other.

The magnitude as well as seriousness of the endemic
industrial sickness that has been plagueing the Indian
economy may well be observed from the several reports
published by the Reserve Bank of India (RBI; 1977-78, 1979-
80, 1981-82). Table 1.1, gives the number of sick units
and the total blocked capital in small, medium and large
scale sectors of the industry. An inspection of the
Table suggests that there has been a steady increase in
the number of sick units belonging to the medium and large
scale sectors. In December 1976, these sectors accounted for

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* According to the RBI classification, enterprises having
  a total value of assets of Rs.10 million or above belong
  to the medium and large scale sectors.

TABLE 1.1 : Number of Sick Units and Total Blocked Capital in Large, Medium and Small Sectors of Indian Industries.

Reporting Time	Large and Medium Sector		Small Scale Sector	
	No. of Sick units	Total Blocked capital $(\times 10^6$ Rs.$)$	No. of sick units	Total Blocked capital $(\times\ 10^6$ Rs.$)$
December 1976	241	6,090	*	*
December 1977	289	8,590	8,000	2,000
June 1978	325	9,568	*	*
December 1978	334	9,830	*	*
June 1979	345	11,017	16,805	1,817
December 1979	378	11,584	20,905	2,620
June 1981	422	14,530	22,355	2,960
June 1982	435	17,290	26,973	3,320

* Statistics not available.

Source: Reserve Bank of India bulletins.

241 sick units with a blocked capital of Rs.6,090 million. The number increased to an alarming figure of 435 sick units with a blocked capital of Rs.17,290 million by June 1982. This implies that on an average every year about 35 units belonging to the medium and large scale sectors have fallen sick. Relatively, there seems to be paucity of reliable data regarding the number of sick units in the small scale sector. However, based on the scanty information published by RBI, it is observed that in this sector also there has been a steady increase in the number of sick units. By the end of the year 1977, there were about 8,000 units identified as sick with a locked-up credit of Rs.2,000 million. The number increased to an alarming figure of 26,973 units with a locked-up credit of Rs.3,320 million by June 1982. The data given in Table 1.1 amply demonstrate that the Indian economic system has been put under severe strains on account of the huge amount of capital blocked in the sick units.

Table 1.2 shows an industry-wise breakup of the sick units in seven major private industrial sectors (RBI, 1977-78, 1979-80). It is noted that the Engineering Industry Sector tops the list of sick mills in number as well as the total amount of capital locked-up. This sector is closely followed by the cotton textile sector.

TABLE 1.25 Industry-wise Breakup of Sick Units in Large and Medium Sectors.

	December 1977			June 1978			June 1979			December 1979		
	No. of units	Blocked capital (X10⁶Rs)	Percent of total blocked capital	No. of units	Blocked capital (X10⁶Rs)	Percent of total blocked capital	No. of units	Blocked capital (X10⁶Rs)	Percent of total blocked capital	No. of units	Blocked capital (X10⁶Rs)	Percent of total blocked capital
1. Engineering	96	2673.5	31.1	112	2861.8	29.9	115	3372.5	30.6	130	3938.2	34.0
2. Cotton textile	73	2604	30.3	78	2636.5	27.6	84	2877.1	26.1	88	3088.6	26.7
3. Chemical	17	947.5	11.03	21	1179.5	12.3	23	1350.1	12.3	22	1283.1	11.1
4. Sugar	27	404.9	4.7	31	794.8	8.3	35	1009.5	9.2	46	796.2	6.9
5. Jute textile	30	798.5	9.3	31	765.8	8.0	33	897.5	8.1	33	858.5	7.4
6. Rubber	5	212.2	2.47	5	251.7	2.6	7	340.7	3.1	N.A.	N.A.	N.A.
7. Cement	3 }	943.9*	N.A.	4	136.9	1.4	4	132.1	1.2	N.A.	N.A.	N.A.
8. Others	38		N.A.	43	933.8	9.9	44	1037.4	9.4	59	1620.2	13.9
Total	289	8584.5	88.9	335	9568	100	345	1101.72	100	378	11554.8	100

* Separate information not available.

Source: Reserve Bank of India.- Report on Currency and Finance, 1977-78 and 1979-80, RBI- Bulletin June 1981.

These statistics clearly bring out that the engineering and cotton textile sectors have contributed about 60.7% of the total locked-up capital in sick units during the periods under consideration and these are the two major sectors of industry where the phenomenon of sickness is rampant. The individual contributions by these sectors being 34% and 26.7%, respectively. The engineering sector includes an assortment of manufacturing units producing varied items, i.e., iron and steel, machinery, electrical equipments, etc., while the cotton textile sector produces one single item, namely, cotton textile. Thus, it is reasonable to conclude that the cotton textile sector, which produces a single homogenous output suffers from the prostration of sickness and carries the highest incidence level.

1.2. Definitions and Causes of Industrial Sickness

An industrial unit is an aglomeration of various functional areas: production, finance, marketing, personnel, and corporate management. If any one of the functional areas develops some sort of abnormality, it may lead to the whole unit becoming sick. However, the term abnormal functioning may have different meaning and interpretations to the workers, management, investors, banks, and the

financial institutions. For example, to the workers in a unit, an abnormal functioning may mean untimely payment of wages, increments and bonuses. Inadequate rate of return on investment may suggest abnormal functioning of the unit to the management and investors. The banks and financial institutions, on the other hand, may measure the functioning of the unit in terms of its capability to generate reasonable surplus to meet its contractual obligations.

1.2.1. Industrial Sickness Defined

Several definitions of the term industrial sickness are to be found in the literature and in practice. According to the Reserve Bank of India, a sick unit is one which has incurred a cash loss for the last year of its operations and in the judgement of the financing bank it is likely to continue to incur cash losses for the current year as well as in the following years. Further, such a unit has an imbalance in its financial structure, namely, the current ratio is less than one, and there is a worsening trend in debt equity ratio. In simple terms, a sick unit is one which is not able to support itself through internal generation of funds.

Besides the definition provided by the Reserve Bank of India, the following definitions are also worth noting.

1.   "It is a state of affairs when a firm looses cash for two consecutive years".

(Prahlad and Thomas, 1977)

2.   "Those units whose owned funds have been wiped off to the extent of 50 percent or more and which have incurred cash losses during the last two years."

(Subramaniam, 1979)

3.   "A unit is sick if one or more of the following symptoms exist:

(i)   The unit is being woundup,

(ii)   The unit has remained closed for a period of not less than three months -- and the closure of which is prejudicial to the textile industry, and the condition of the undertaking is such that it may, with reasonable inputs be re-started in the interest of the general public.

(iii)   The unit has been leased to Government or any other person or the management of which has been taken over by the Government or any other person under any lease or licence granted by any Receiver or Liquidator or under the orders of, or with the approval of, any court.

(iv)   The management of the unit was authorised by
        the central government --- to be taken over --- but
        such management could not be taken over ---."

                    (The Sick Textile Undertakings (Taking over
                     of Management) Act, 1972, No.72 of 1972.)

4.   "Sick textile undertakings mean the textile under-
        takings which falls within one or more of the
        following categories, viz.,

(i)   Negative working capital.

(ii)   Cash flow declining in relation to the revenue
        commitments for three successive periods.

(iii)   Insufficient earnings before interest and taxes.

(iv)   Negative net worth."

                                        (Raman, 1979)

        The multiplicity of definitions of the term sickness
stem from a wide variety of concerns that are behind each
definition. The concerns may range from profitability to
social welfare. Some of the definitions incorporate
explicit measurements while the others involve judgemental
factors and the complexities of measurement may vary from
univariate deterministic to multivariate probabilistic.
Moreover, the ambiguities in defining the phenomenon
increase if the organization defining it is different from
the organization dealing with it. This arises due to lack of

comprehension on the part of the defining organization
to conceive of all the contigencies which might bear upon
the actual situation. Thus, what constitutes industrial
sickness is neither precise nor clear and to state to what
extent it is prevalent in the Indian industrial scene cannot
be scientifically stated. Different definitions would
result in different empirical estimates. Mostly the
figures quoted on sickness in Indian industries are based on
the definition provided by the Reserve Bank of India.

1.2.2. General Causes of Industrial Sickness

Bidani and Mitra (1982) have broadly classified
the causes of industrial sickness into two categories,
namely, the internal causes and external causes. Internal
causes arise due to internal disorder in the functional
areas of finance, production, marketing, and personnel.
The malfunctioning of the units arising due to the internal
causes is considered to be controllable to a great extent
by providing effective corporate management. External
causes associated with the four functional areas are
normally beyond the control of the unit and arise due to
the change in the social, political, and international
environment. The critical factors under each of the four
functional areas are shown in Figure 1.1 (Bidani and Mitra,
1982, p. 49).
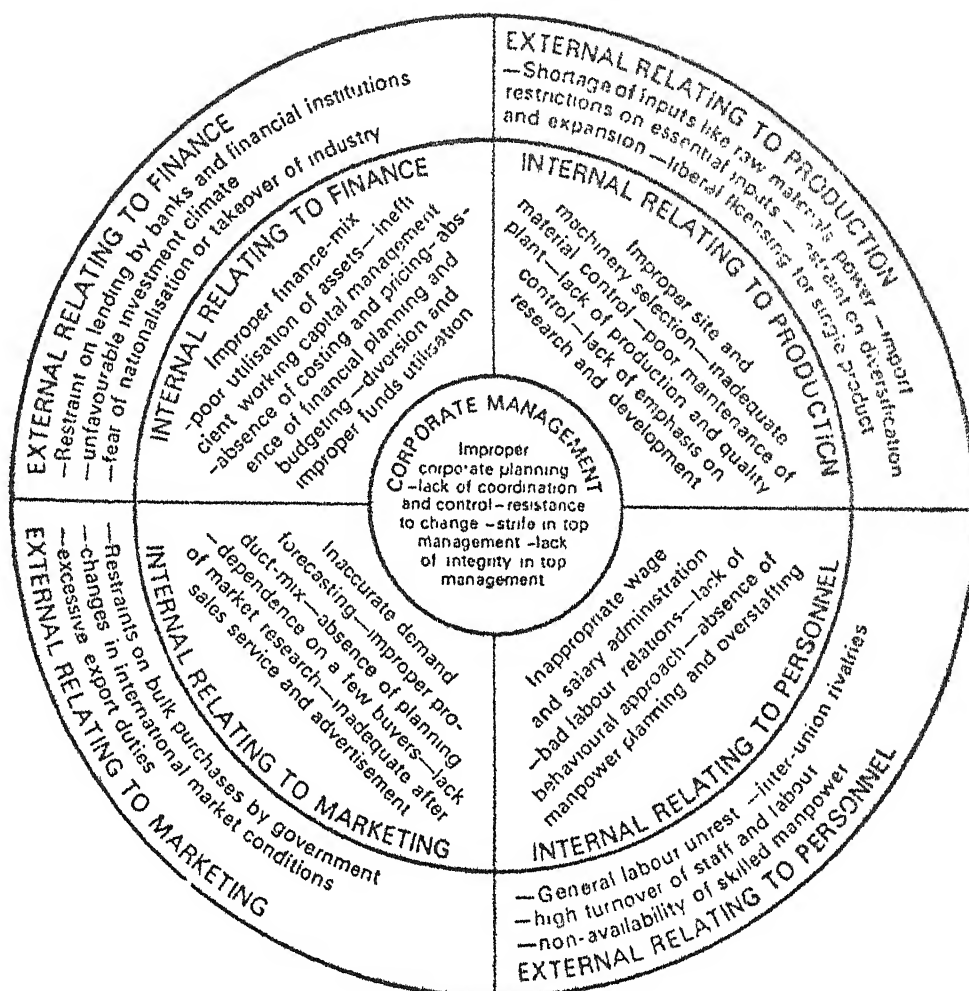
FIGURE 1·1. GENERAL CAUSES OF SICKNESS

In majority of cases an industrial unit becomes
sick due to the conjoint effect of the several causes/
factors. The various factors which have specifically
contributed to the rampant sickness phenomenon in cotton
textile mills are discussed in Chapter III.

1.3. Motivation and Objectives for the Present Study

The modelling and assessment of sickness is a complex
task since cognizing the health status of a mill requires
identification of numerous factors and processing of a
large volume of data rudimenting from a variety of performance
aspects. Considering the complexity of the problem, the
financial institutions, more often than not, decide upon
the health status of an industrial unit simply based on
financial aspects. Even based on these aspects, there are
a variety of definitions for the term, "sickness". These
definitions use different financial norms, viz., erosion
of equity, generation of surplus liquidity and solvency
position, the amount and period of irregularities, etc.
As such, most of the sickness criteria view the phenomenon
from one specific angle and do not account for the multi-
plicity of factors which bear upon the performance of a
mill. For example, the definition of the term sickness
provided by the RBI, views sickness from financial considera-
tions (Section 1.1) and calls for a loss or expected loss

during the previous, present, and the coming financial
years with current liability to assets ratio greater than
one. Various banks and financial institutions generally
use this definition to decide upon the health status of a
cotton textile mill and its fitness for the rehabilitation
program.

The current RBI procedure for assessing the health
status of a textile mill based on the above definition
suffers from the following drawbacks:

(1) The sickness norms are too general and vague, and
     their application frequently results in indecisions
     and conflicts (Piramal, 1981).

(2) It fails to consider as to how a mill under
     appraisal is performing with reference to other
     contemporary mills under similar circumstances.

(3) It ignores the fact that the health status or the
     overall performance of a mill is the net effect of
     the synergetic combination of elements stemming
     from the financial, productive, personnel, marketing,
     and other aspects of management.

(4) It considers only one aspect, i.e., the financial
     losses during the previous, present and the coming
     year. The definition does not consider all the

relevant economic and operational aspects reflecting the short-term or yearly performance of the mill. Further, long range performance indicator, viz., risk, stability and resilience of the mill are not duly accounted for the assessment of the health status before declaring a mill sick.

Therefore, there is a need for developing a more scientific basis for cognizing the sickness phenomenon and assessing the health status of cotton textile mills. This would require a systematic and in-depth study of this vital sector of our industrial economy. In order to achieve this objective, in the present study we have attempted to

(i) comprehend the problem of sickness in the organized sector of cotton textile industry with a view to identify the causal elements and their interactions;

(ii) develop a hierarchical structure of the interactive elements identified in step (i);

(iii) identify several attributes which represent different aspects of performance of a textile mill on yearly basis;

(iv) investigate the behavioural pattern of the several performance attributes selected in step 3 using the empirical data for randomly selected mills;

(v)   develop surrogates encompassing the short-term
        (yearly) and long-term performance aspects of mills;

(vi)   formulate a decision rule for the assessment of
        the health status of a mill based on short-term and
        long-term performance surrogates.

1.4. The Methodology of Investigation

        The present work deals with structural modelling
of sickness phenomenon and development of a model to assess
the health status of a textile mill. The cognition of the
health status of a textile mill requires looking into the
causes attributable to the sickness phenomenon as well as
the identification of attributes reflecting the short-term
and long-term performance of a mill. In the course of
this research we have drawn upon the knowledge from
different disciplines, viz., systems engineering, multi-
variate statistical techniques and normative financial
theory.

        In the present work we firstly, develop a conceptual
insight into the sickness phenomenon by reviewing the
literature which primarily comprised of descriptive
studies. Additional information has been obtained from
experts through personal interviews. The information
generated is utilized to develop an Influence Digraph (ID)

and an Interpretive Structural Model (ISM) of the sickness
phenomenon. This is done iteratively. The ISM is
advantageously used to interact with the field people in
order to identify a set of 14 attributes which are considered
to be good indicators of short-term performance of textile
mills. Essentially these attributes are in terms of
financial, economic and physical efficiency measures and
are based on the performance of a mill during a particular
year.

Empirical data pertaining to all the fourteen
attributes is collected and analysed for a sample of 75
randomly selected textile mills for the period April 1971
to March 1981. The sample comprises of 42 composite and
33 spinning mills. The results of descriptive statistics
provide an insight into the behaviour of the organized
sector of industry over a period of 10 years. Considering
a textile mill as a physical entity and the 14 attributes
as a battery of tests, we look for common traits or factors
running through these attributes. To that purpose the
technique of Factor Analysis is used. The analysis is
performed on 10 years empirical data concerning the 75
mills in the sample.

The basic assumption in factor analysis is that
a set of interconnected variables can be represented by

means of hypothetical constructs which carry the influence
of the original set of variables. These constructs, in
a way, are groupings of the original variables into a
number of factors. Each factor consists of a linear
combination of the original variables included in the
analysis.

Using the empirical data, five factors have been
extracted accounting for 73.4% of the generalized variance
of the 14 attributes. These factors have been called
Short-term Performance Surrogates. Another surrogates,
which aggregates these factors by assigning weights to
them, is developed and termed Weighted Short-term
Performance Surrogate (WSPS).

We also consider the long-term performance of a mill
in terms of its risk, stability and resilience. The
researchers in the capital market instruments use risk
coefficient to assertain the degree of uncertainty
associated with the realization of future expected rate of
return. The second surrogate., viz., stability coefficient
measures the ability of the industrial unit to maintain
a steady state performance inspite of small or temporary
perturbations. On the other hand, the resilience coefficient
assesses the ability of the industrial unit to be in steady
state inspite of large or permanent perturbations. Risk,

stability and resilience coefficients have been evaluated
for all the mills in the random sample using their past
performance data for the period of 10 years, i.e., April
1971 to March 1981.

We then proceed to form a decision making criterion
using discriminant analysis which would enable us to
classify any mill into one of the two groups: healthy
and sick. To that purpose 17 mills, whose case history is
well-established, have been selected. For the year 1980-81,
out of these mills 10 were reported as healthy and the
remaining 7 as sick based on the information provided by
the RBI and Stock Exchange Foundation Bulletin, 1982.
Discriminant functions considering several combinations of
surrogates have been developed in an effort to select
the one with the highest discriminating power. In addition
a threshold value is determined for the selected discriminant
function.

The discriminant function is used to obtain
discriminant score which (when compared with the threshold
value) classifies each of the 75 mills into one of the
two groups.

1.5. Organization of the Study

The present work consists of seven chapters.
Chapter I describes the magnitude of sickness phenomenon

in Indian industries and spells out the objectives of
present work. A brief description of the approach for
investigation is presented. Chapter II gives a general
perspective of the cotton textile industry and traces
its sickness scenario. Chapter III is a survey of
the various descriptive and predictive studies reported
in the literature on the sickness phenomenon with special
reference to textile mills.

Chapter IV presents the development of an Influence
Digraph (ID) and the Interpretive Structural Model (ISM)
of the sickness phenomenon. Chapter V is concerned with
the selection of a set of 14 attributes representing
financial, economic and physical efficiency aspects of the
textile mills. This chapter also deals with a study of
the behavioural pattern of the textile mills with respect
to the attributes over a period of 10 years. In Chapter VI
the development of various surrogates reflecting short-term
and long-term performance of textile mills is presented.
Finally, in Chapter VII we consolidate the results of the
previous analysis and present the limitations of this study
alongwith the directions for future research.

CHAPTER II

INDIAN COTTON TEXTILE INDUSTRY - A PERSPECTIVE

This chapter presents a brief account on the
structure of Indian Cotton Textile Industry and gives a
spatial distribution of textile units in the country.
Salient statistics on men, machines, material and money
deployed by the industry are presented in a condensed form
through graphical representations. A brief account of the
sickness scenario in cotton textile industry and the govern-
mental measures which have bearing on the functioning of
textile industry are also given.

2.1. Basic Structure of Cotton Textile Industry

The cotton textile industry occupies a special place
in almost all countries and more so in India. It is the
oldest and one of the largest industries in the country.
It contributes on an average about 20 per cent towards the
total industrial production of the country. The socio-
economic impact of this industry is in the form of liveli-
hood for nearly 10 million workers through non-organized
sector and about 0.8 million workers through mill sector.
Indirectly the industry also supports a large number of
cotton cultivators and agricultural labourers. The industry
is basically divided into two categories: (1) organized or
mill sector, and (2) non-organized or decentralized sector.

(1) <u>Organized or Mill Sector</u>:   It consists of:

    (a)   spinning mills engaged in the spinning of yarns
          for weaving in mills as well as in the non-
          organized (handloom & powerloom) sector; and

    (b)   composite mills engaged in spinning as well as
          weaving jobs.

(2) <u>Non-organized or Decentralized Sector</u>:   It consists of:

    (a)   powerlooms and handlooms, which generally
          depend on mill sector for their requirements of
          yarn, the primary input; and

    (b)   processing units which process the cloth
          manufactured by the non-organized sector.

In the Annual Survey of 1980, published by the Textile Commissioner's Office, Bombay, it is reported that there are 19.5 million looms and 0.208 million spindles installed in the country. A total of 989 million kg. of yarn and 8,314 million meters of cloth was produced during the year 1980. The organized mill sector has been reported to contribute 41.8% while the handlooms and powerlooms have contributed 58.2% of the total production of woven cloth. Table 2.1 portrays the statistics on total cloth production and the contribution by the organised sector during the period 1971 to 1980.

TABLE 2.1 : Share of the Organized Sector of Cotton Textile
Industry for cotton cloth production.

Year	Total cloth produced (X 10^6 meters)	Production of cloth in orga- nized sector (X 10^6 meters)	Share of organized sector (%)
1971	7356	3957	53.8
1972	8022	4245	52.9
1973	7771	4169	54.1
1974	8284	4316	52.1
1975	8034	4032	50.2
1976	7945	3881	48.9
1977	6901	3223	46.7
1978	6901	3251	44.0
1979	7325	3206	42.5
1980	8314	3476	41.8

Source: Textile Commissioner's Office Bulletin, 1981.

2.2. Demand Perspective

On the demand perspective the report published by
the National Sample Survey (Madan, 1975) provides a
reasonable picture on the consumption of cotton textiles
by the various strata of Indian society. The survey
revealed the following:

(1)   On an average upper 5% of the India's population
        consumes 51.3 meters/head per annum.

(2)   Upper middle 5% of population consumes 39.5 meters/
        head per annum.

(3)   Middle 20% of the population consumes 11.9 meters/
        head per annum.

(4)   Lower 40% of the populace consumes between 0.8 to
        3.3 meters/head/annum.

(5)   No apparent consumption is found for 30% of the
        lowest wrung of the Indian society.

The National Productivity Council (NPC, 1978)
claims that there has been an increase in the consumption
of cotton textiles by the Indian population aspiring for
better quality of life.

2.3. Operation Sequence in Cotton Textile Manufacturing

Figure 2.1 portrays a process sequence chart of
the activities involved in the cotton textile manufacturing.

The two broad categories -- spinning and weaving -- have
been described through this Figure showing the sequence
of operations involved. In a spinning mill, the basic
machine unit is a spindle or a ring frame on which yarn
is spun. The spun yarn is woven as warp and weft on looms
which constitute the second most important machinary of
the textile industry. Normally a set of 50 spindles can
feed yarn to one single loom. Therefore, in a composite
mill where both spinning and weaving operations are performed,
the spindlage to loomage ratio is generally 50:1. Two
types of spinning machines -- , spindles and ring frames --
and 3 types of looms -- plain looms, dobby and jacquard --
are in common usage in the composite mills. These looms
weave either plain (calico, long-cloth, cambric, mull, canvas)
or twill (drill, jean, shirtings) or satton cloth. Based
on the needs and requirements of the market, a large variety
of product mix is turned out by the mills. For a spinning
mill the variety of product is decided on the basis of the
yarn count.

2.4. Salient Statistics on the Organised Sector

The organised sector of the industry comprises of
691 spinning and composite mills. These mills are spread
spatially over the length and breadth of the country and
are divided into 21 administrative regions. These regions
are further grouped into 4 zones. The various textile mills

received research and development support through voluntary membership of any of the four textile research associations namely, Ahmedabad Textile Industry's Research Association (ATIRA), Bombay Textile Research Association (BTRA), South India Textile Research Association (SITRA) and newly created North India Textile Research Association (NITRA). Table 2.2 gives the regional distribution of men, machines, material and capital deployed in the organised sector of the industry as per 1980 census of the Textile Commission's office, Bombay. Zones 1 through 4 given in Table 2.2 refer to the normal domain of activities of ATIRA, BTRA, SITRA and NITRA, respectively.

Figure 2.2 displays the number of units in a region on the X-axis whereas manpower employed by the total number of mills in the region are presented on Y-axis on a log-log scale. This figure depicts the relative size and regional concentration of mills in different parts of the country. It is observed that 49% (411.622 million) of the labour force employed in the organized sector is engaged in 46% of the mills (297) which are located in three regions. These regions are: region 1 (Ahmedabad urban), region 3 (Bombay urban) and region 16 (Tamil Nadu). Thirty per cent (254.974 million) of labour force has been employed in 192 mills located in regions 2, 4, 12, 15 and 17. The remaining 149 mills account for only 21% of the work

TABLE 2.2 : Gross Statistics concerning Organized Mill Sector of Cotton Textile Industry (Excluding NTC Mills)

Zone No.	Region No.	Name of the Region	No. of Mills	Labour emplo- yed (X1000)	No. of spind- les (X1000)	No. of Looms (X1000)	Cotton Bales consumed (X1000)	Paid up Capital (X10^6 Rs.)
1	3	Ahmedabad city	66	141.30	2674.30	47.64	822.88	530.36
1	4	Rest of Gujrat	46	55.16	1316.97	16.49	440.98	178.97
2	1	Bombay city	54	165.12	344.28	62.04	1177.16	674.83
2	2	Rest of Maharashtra	52	63.19	1507.06	15.73	552.60	270.64
2	21	Goa	1	1.626	25.00	N.A.	2.933	N.A.
3	11	Andhra Pradesh	31	18.546	740.29	1.72	231.11	74.16
3	16	Tamil Nadu	177	105.19	4899.21	9.88	1357.64	633.19
3	17	Karnataka	31	36.01	810.23	6.522	322.42	164.11
3	18	Kerala	26	13.51	538.70	1.169	129.09	57.05
3	19	Pondichery	5	9.68	142.53	2.58	100.61	15.59
4	5	Rajasthan	16	19.09	426.42	2.79	247.83	723.19
4	6	Haryana	11	13.91	258.74	0.98	170.23	18.79
4	7	Punjab	9	16.70	270.50	1.47	278.16	98.33
4	8	Delhi	4	14.47	166.31	3.37	125.99	205.95
4	9	Assam	2	1.145	36.01	N.A.	2.17	10.78
4	10	Uttar Pradesh	31	44.39	1136.14	13.35	341.76	206.47
4	12	Madhya Pradesh	23	48.19	736.35	12.02	297.38	186.49
4	13	Bihar	6	2.24	93.62	0.596	27.59	10.42
4	14	Orissa	5	6.524	122.33	1.01	102.22	19.52
4	15	West Bengal	40	52.39	1025.15	10.05	307.92	316.87
4	20	Jammu & Kashmir	1	1.626	25.00	N.A.	2.933	N.A.

Source: The Stock Exchange official Directory, No. XVI/9, Vol. 8, 22(iv), September 1982.

N.A. - Data not available.

force. Region 16 (Tamil Nadu) has the highest number of
mills, viz., 177 (23%)   employing only 12.6 %
of the total workforce. On the other hand, regions 1 and
3 have 120 mills (18 %)   employing 36 per cent of
the total work force. Therefore, in terms of the average
work force deployment regions 1 and 3 have larger units,
whereas region 16 has smaller units.

Figure 2.3 depicts a log-log plot between number of
mills and spindles installed (in 1000's) and gives the
status of installed spindles in the various administrative
regions. It is observed that twenty three per cent of the
total spindles in the country are installed in 177 units
located in the region 16 (Tamil Nadu) while regions 1, 2,
3, 4 and 5 account for forty three per cent of the total
installed spindlage. The remaining 34 per cent of spindlage
is installed in rest of the regions.

Figure 2.4 portrays a log-log plot between number
of spindles (in 1000's) and loomage (in 1000's). A
straight line marked A-A' on the figure with a slope of
1/50 provides a parting line demarcating the regions having
concentration of composite mills from regions having
concentration of spinning mills. On figure 2.4 all regions
which fall near the line A-A' have mills mostly engaged in
the composite task. The regions where the organized mill-
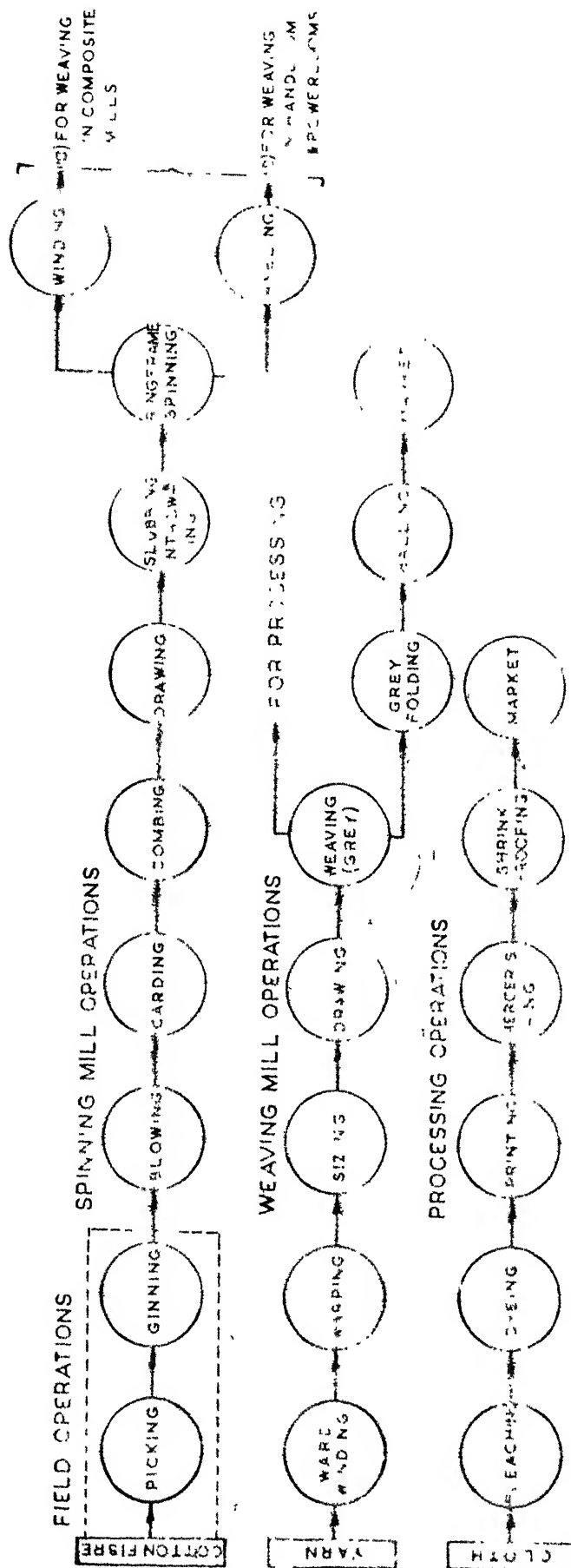
FIGURE 2.1. PROCESS SEQUENCE IN COTTON TEXTILE MILLS.
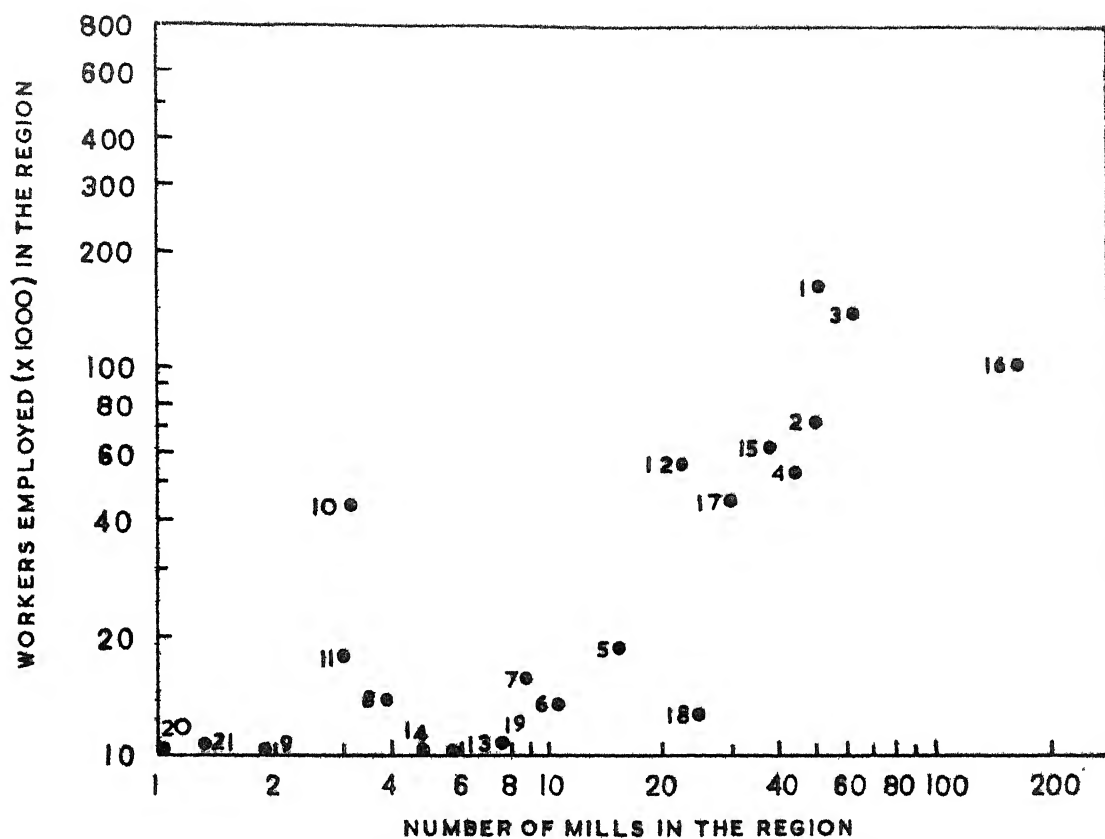
FIGURE 2·2. NUMBER OF MILLS AND WORKERS EMPLOYED IN VARIOUS REGIONS (FOR REGION CODE SEE TABLE 2·2)
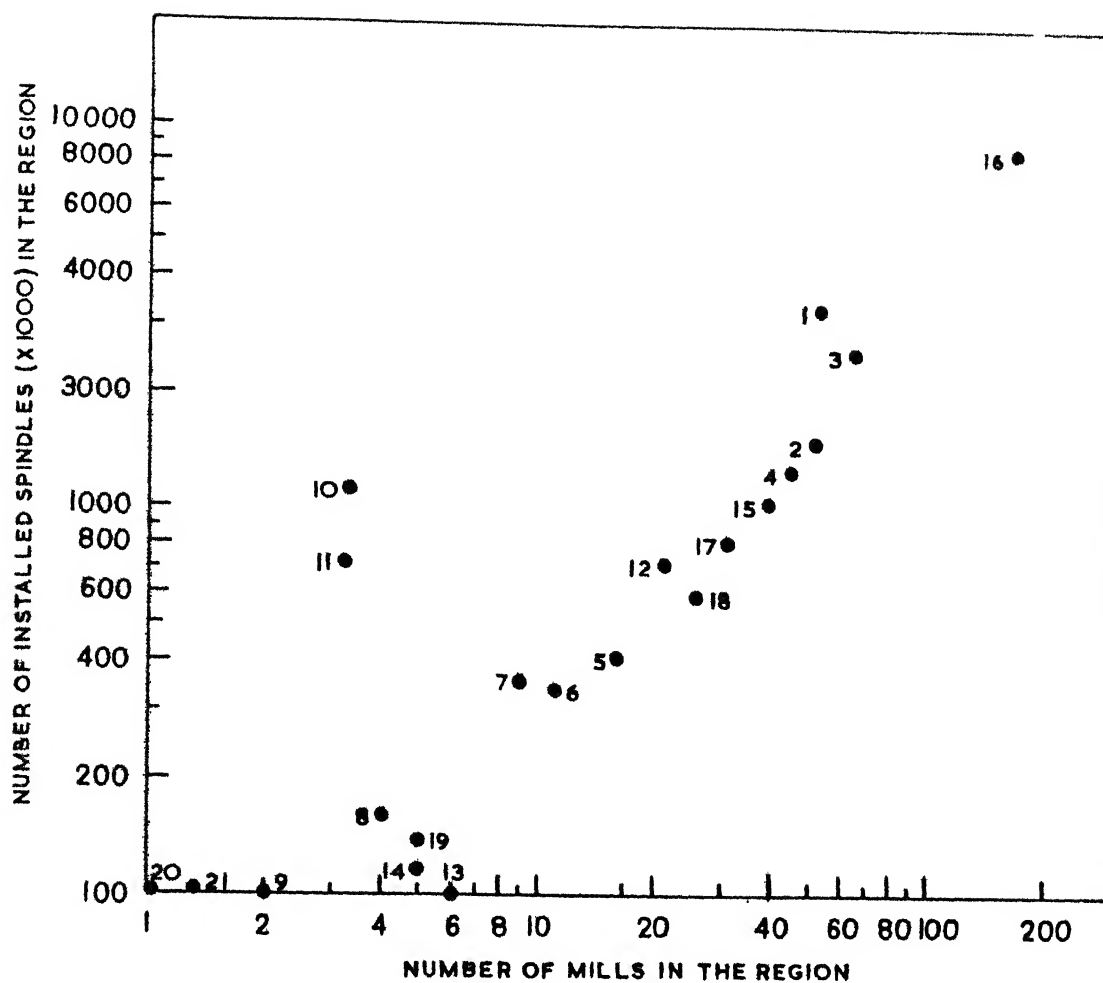
FIGURE 2·3. NUMBER OF MILLS AND SPINDLES INSTALLED IN VARIOUS REGIONS (FOR REGION CODE SEE TABLE 2·2)
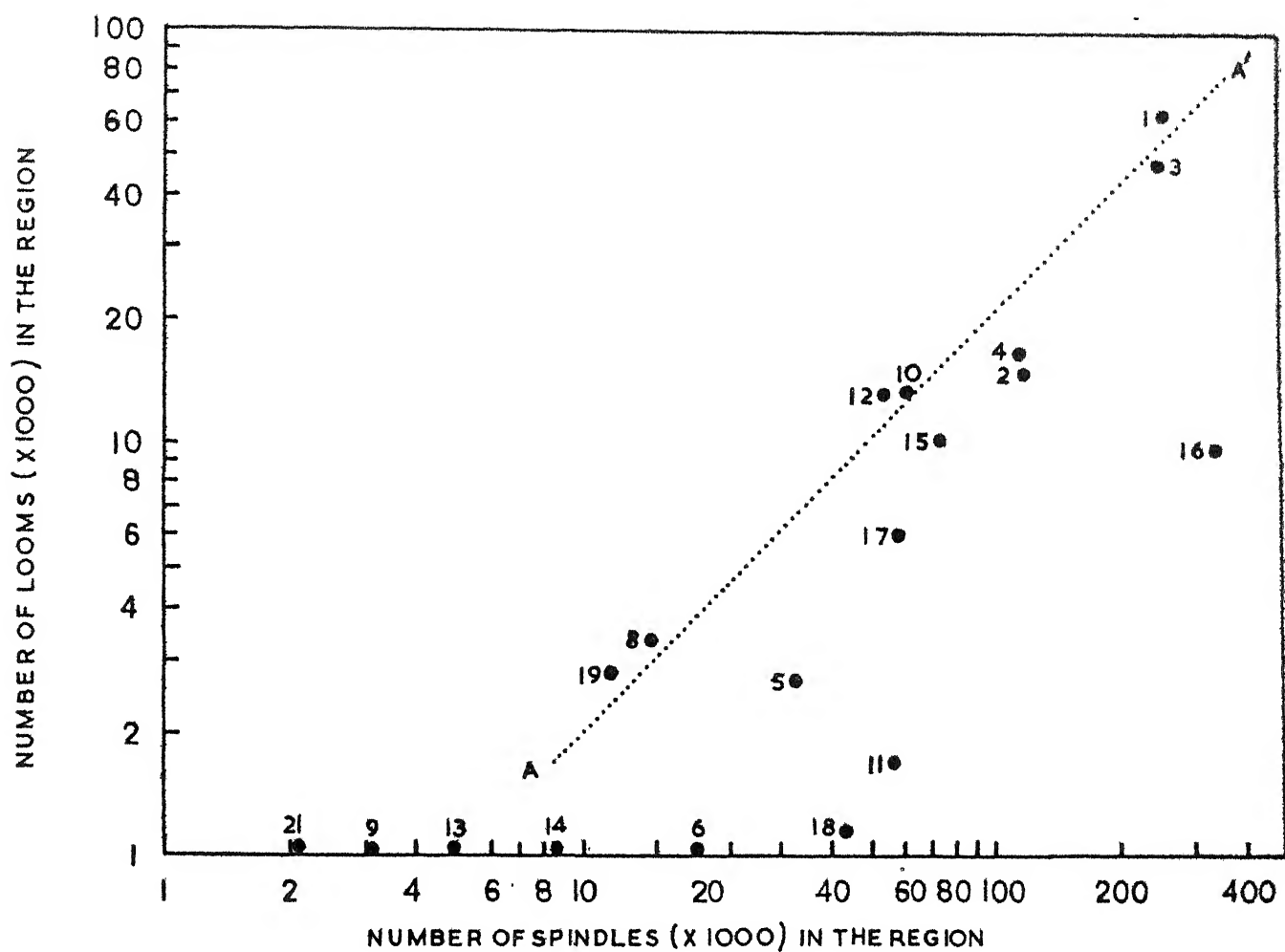
FIGURE 2·4. NUMBER OF SPINDLES AND LOOMS IN VARIOUS REGIONS (FOR REGION CODE SEE TABLE 2·2)

sector mostly supplies its end product in the form of yarn are located far below the line A-A'. It is also noticed that regions 1,3,8, 10 and 12 have predominantly composite mills (lying on the 1/50 slope line), whereas, region 16 lies far below the line indicating the concentration of spinning mills in this region.

Figure 2.5 displays a log-log plot between the number of mills and the total number of cotton bales consumed. This display shows that region 16 consisting of 177 mills alone consumes 19% of the cotton bales, whereas regions marked 1,2,3, and 4 consisting of 218 mills consume 55% of the total cotton requirements of the industry.

In Figure 2.6, the distribution of the paid-up capital versus number of mill located in the 21 regions has been ploted on a log-log scale. From this figure, it is observed that regions 1,7 and 8 have mills with very high paid-up capital per mill, viz., over Rs.100 million per mill, whereas region 16 has mills with paid-up capital of less than Rs. 40 million per mill.

2.5. Sickness Scenario in Cotton Textile Industry

The organized sector of cotton textile industry comprises of spinning and composite mills whereas the non-organized sector is composed of handlooms, powerlooms and
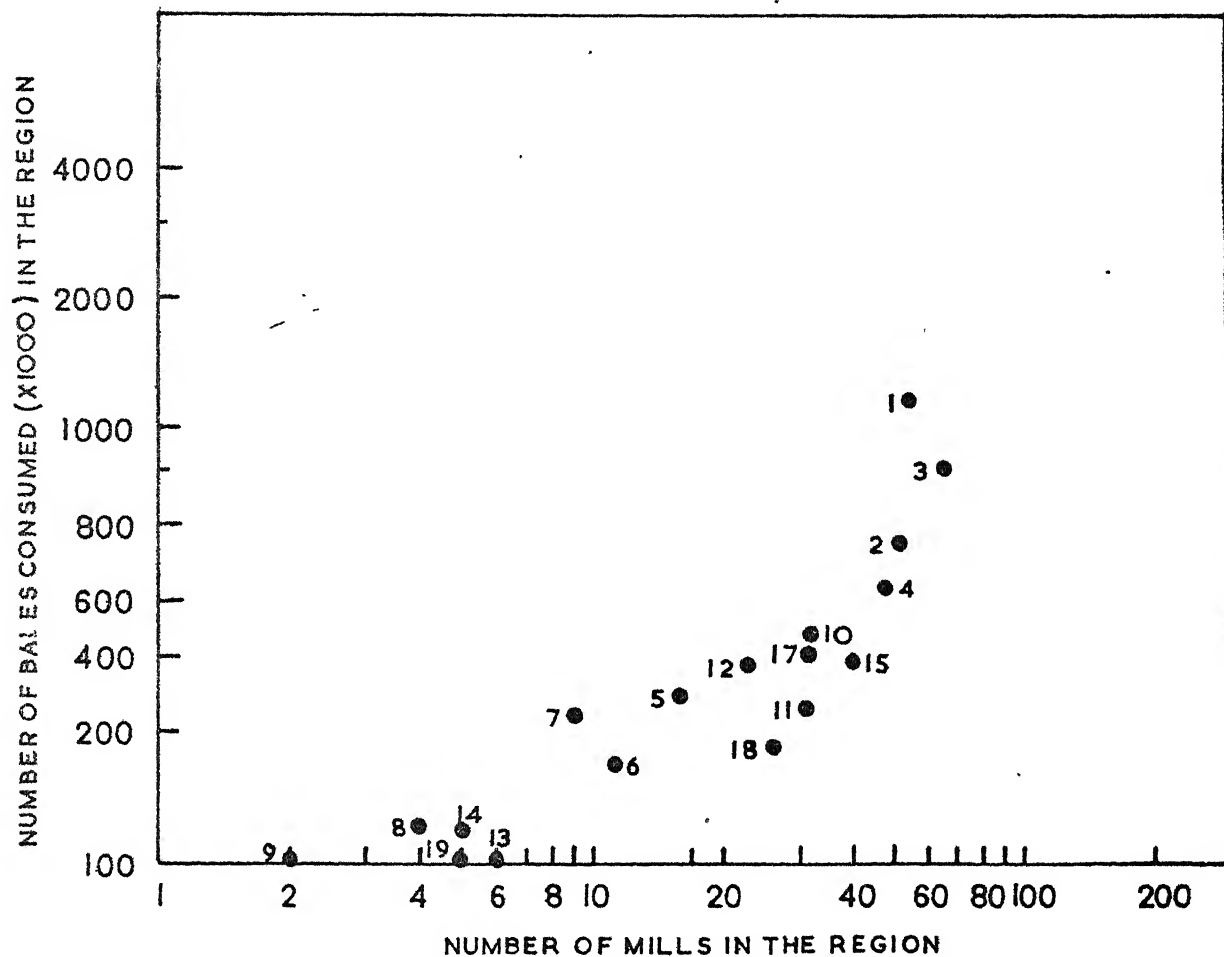
FIGURE 2·5. NUMBER OF MILLS AND BALES CONSUMED IN
VARIOUS REGIONS (FOR REGION CODE SEE TABLF 2·2)
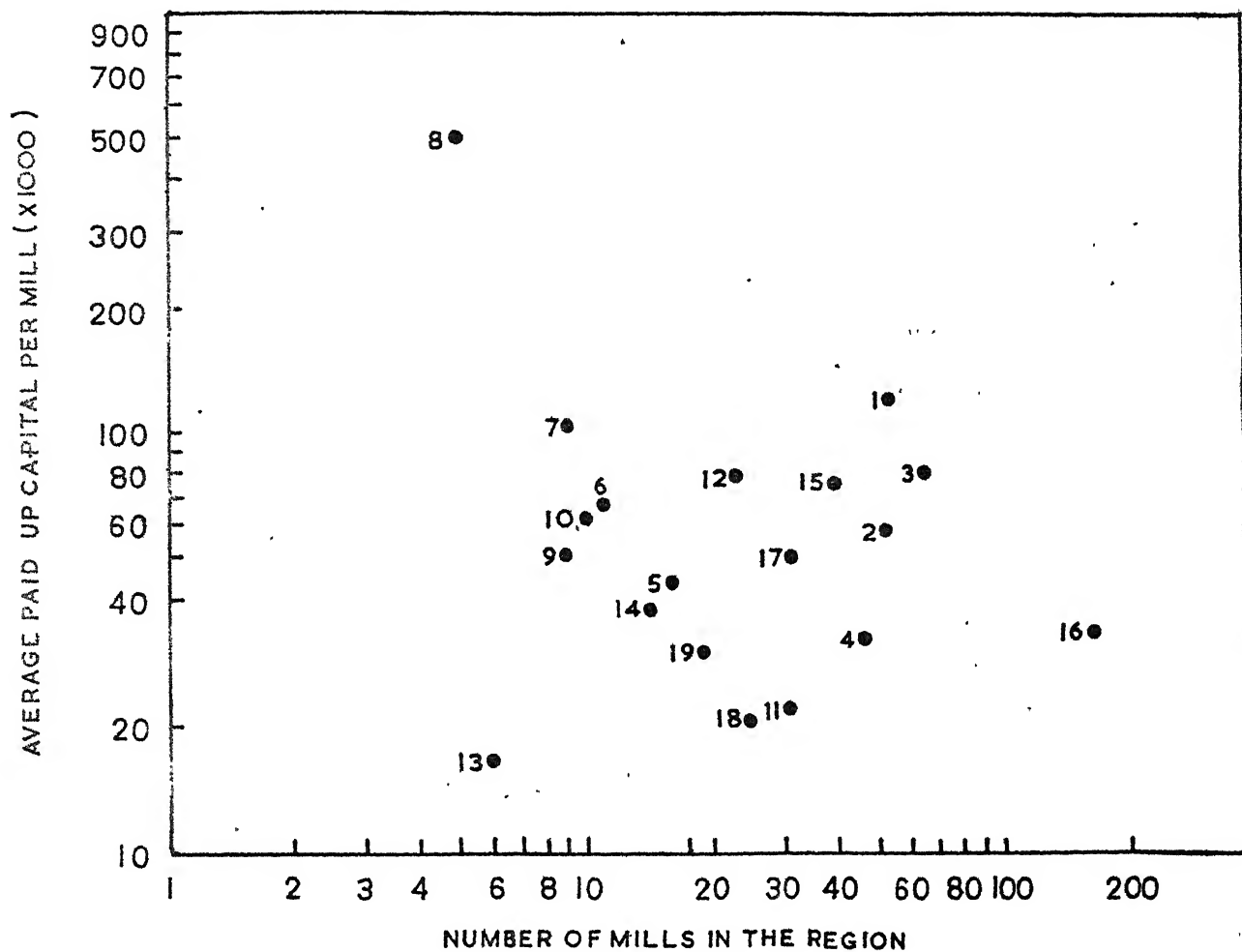
FIGURE 2·6. NUMBER OF MILLS AND AVERAGE PAID UP CAPITAL PER MILL IN VARIOUS REGIONS (FOR REGION CODE SEE TABLE 2·2)

processing units. According to the 1981 Annual Survey
published by the office of Textile Commissioner, Bombay,
there were 691 cotton textile mills in the organized sector
of the industry. As early as in 1951, the existance of
about 150 weak textile mills was recognised during the
preparation of the First Five Year Plan for the country.
The government appointed a National Development Corporation
to provide financial assistance for renovation and moderni-
zation of these weak units. In 1967, the National Textile
Corporation (NTC) was established under the Cotton Textile
(Management of Undertaking Liquidation or Reconstruction) Act
with a view to provide direct management, renovation and
rehabilitation of sick mills as well as to arrange the supply
of raw cotton at no profit no loss basis. In 1968, NTC took
over the management of 16 mills which were earlier managed
by the government. By December, 1979, the number grew to
116 mills, which included 103 takenover sick mills and
13 newly established spinning units. The total number of
units managed by NTC and its subsidiaries remained static
until October 19, 1983 when a Presidential Ordinance entitled
Textile Undertakings (Taking over of Management) Ordinance,
was promulgated and the management of 13 textile mills in
the Bombay region was handed over to NTC. Thus, currently
there are 129 textile mills managed by the NTC and its
subsidiaries.

Referring to the Table 1.2 (Chapter I), we observe that in December 1977, there were 73 sick mills with blocked capital of Rs. 1604 million. In a short span of 2 years, i.e., by December, 1979, the number of sick textile mills rose to 88 and the blocked capital increased to Rs.3088.6 million. The data on the number of sick cotton textile mills and on the number of sick mills whose management has been takenover by NTC and its subsidiaries clearly suggest that the cotton textile industry has been in a bad shape for a long spell of time and it continues to do so.

Although public debate on the phenomenon of sickness in the textile industry started with the formation of NTC in 1968, the possible dangers that this industry could face in future were expressed by the Working Committee for the Textile Industry in its Report of 1952. Another committee appointed in 1960, simply endorsed the views of the Working Committee Report and also suggested the same rehabilitation measures for closed and sick units. It was only in 1968 that the government thought of making serious attempts to tackle the sickness problem in the textile and sugar industries.

2.5.1. Governmental Measures

Social welfare is the guiding factor for policy
planning in India. In view of this, the Government of
India has shown great concern in the working of cotton
textile industry in which there is huge capital investment.
Further, its poor performance hurts the interests of a
large cross-section of society. The government has also
introduced a number of legislations and tariff control
regulations in order to check the price rise on the cotton
cloth and make it available to people belonging to the
lowest strata of income (Padmanabhan, 1979; Paranjape, 1980).
The government has also established a Cotton Corporation
of India (CCI) to protect the interests of the cotton
growers. CCI is an apex body involved in the marketing
of cotton fibre.

The Government of India, through its financial
institutions has from time to time devised measures to
tackle the problem of growing industrial sickness in the
cotton textile sector. As a matter of policy, the government
has been laying great emphasis on the reconstruction of
sick textile mills. The reconstruction process is marked
through giving of soft loans and subsidies as well as the
permission of merger of a sick unit into large healthy
unit. Industrial Development Bank of India (IDBI) and

Industrial Reconstruction Corporation of India (IRCI) are two such agencies which look after reconstruction activities related to sick textile mills. These agencies not only work as lending institutions but act also as reconstruction agencies and are entrusted in diagnosing and removing short-comings which have led the units to sickness.

In July 1976, the government issued guidelines to the banks to enable them to analyze and interpret the data contained in the annual/quarterly statements received from the mills in order to serve as an early warning system to provide signals of incipient sickness. The banks were also advised in November, 1976 to submit to RBI quarterly statements giving particulars of all sick units enjoying credit facilities aggregating to Rs. 10 million and above from the banking system.

In March 1978, the Reserve Bank of India set up an inter- institutional group on co-ordination of lending institutions and commercial banks. The group emphasized that the viability of a unit and its ability to repay dues within a reasonable period should be the guiding factors in lending rather than the security alone. The District Industries Centres (DICs) which had been set up all over the country under the auspices of the Ministry of Industry

were asked to identify sick units and restore them to health by offering a package of assistance. A sick textile unit seeking revival under a nursing programme is charged concessional interest rates for its working capital finance and is provided liberal terms with respect to margin stipulations of securities. Further, it is exempted temporarily from the rigours of other guidelines. (Hanumanthappa and Bhat, 1979). The concessional finances given to sick units adopted under the nursing schemes of financial institutions are so tempting that even healthy industrial units with inept management try to pose of themselves as sick units in order to avail of the substantial benefits (NPC, 1976). While it is essential that genuinly sick mills are nursed back to normalcy, care must be taken to see that only needy and really sick units are given these concessions out of the scarce financial resources at the disposal of various governmental agencies.

In May 1978, the government issued a policy statement under which the management of the mill would first explore avenues of rehabilitation. The rehabilitation of the sick units was supposed to be done through the State Governments and financial institutions providing financial and managerial support, or through the merger of the sick units with healthy units in the private sector. If these courses of action could not be feasible or desirable, the question of take-over

of management under the industries (Development and Regulation) Act was considered. A screening committee was set up in order to examine the alternative courses of action and decide upon the most suitable measures to be taken. The committee was required to take into account all the concerned factors relevant to the unit's sickness (Kuchhal, 1980; p. 148).

In March 1981, the government revised the earlier statutory control on cotton textile and increased the production target with increased price of controlled cloth. The controlled cloth under the new policy has now been restricted to fewer items of immediate need for the lowest income group. The following measures have been taken to facilitate the proper functioning of textile mills under March 1981 policy declaration:

(1)   Import of appropriate technology and critical components of machinery will be allowed whereever necessary.

(2)   Ready availability of synthetic fibre and yarn in adequate quantities from domestic sources, augmented as necessary by imports; will be ensured.

(3)   The domestic production base of synthetic fibre and yarn will be expanded so that they are produced at the lowest possible price.

(4)   Fiscal levies on man-made fibre and yarn will be
        reviewed.

(5)   Liberalization in the export of cotton and such
        other fibre/yarn that may be surplus to domestic
        requirements will be allowed.

(6)   In order that cotton is available in adequate
        quantities, the government will ensure that cotton
        growers are assured of reasonable prices for their
        produce.

(7)   The units declared sick will be looked after through
        nursing schemes by IDBI to bring them back to normal
        working.

(8)   The states under whose jurisdiction a sick mill
        falls will be allowed to use the excise revenue
        generated by sick mill as a grant-in-aid or as a
        soft loan.

2.6. Conclusion

        The following conclusions are drawn from the general
perspective of the cotton textile industry presented in
this chapter.

(1)   There is large commitment of resources in the form
        of men, material, machines and money in the organised
        sector of cotton textile industry.

(2)   The textile mills are spatially distributed all
        over the country. However, there are large clusters
        of composite mills in Ahmedabad (region 3) and
        Bombay (region 1). Spinning mills are mainly
        located in Tamil Nadu (region 16).

(3)   A large number of textile mills have fallen sick
        over the years. In 1979 there were 88 sick textile
        mills with a blocked capital of Rs.3088.6. This
        figure excludes the mills under the control of NTC.

(4)   The growth of sickness phenomenon in textile mills
        still persists which is indicated by the taking over
        of 13 mills in the Bombay region by the government in
        October 1983. Unless this phenomenon is checked,
        it will have alarming implications on the Indian
        socio-economic system.

(5)   Over the years, the Government of India through its
        financial institutions has introduced several
        measures including the nursing programmes for sick
        mills. These measures are primarily in the form of
        soft loans to mills which can be rehabilitated and
        taking over the management of mills which are found
        to be beyond redemption.

CHAPTER III

REVIEW OF LITERATURE

This chapter has been organized into three sections.
Section 3.1 deals with descriptive studies related to the
normative aspects of the phenomenon of sickness in the
organized sector of cotton textile industry. Section 3.2
deals with inter-firm camparisons based on productivity
based indices and financial indicators. Section 3.3 covers
prediction studies based on statistical modelling concepts.

The descriptive studies deal with the problem of
sickness in cotton textile industry in a general framework
and provide insight into the phenomenon of sickness.
Inter-firm comparison studies are intended to compare the
relative performance of the firms based on productivity
and financial attributes. On the other hand, the prediction
studies are mainly concerned with developing statistical
models, based on financial ratios.

3.1. Descriptive Studies

A large number of descriptive studies are available
on the problem of sickness in the Indian cotton textile
industry. Most of these are in the form of description
of the events and they mainly attempt to trace the genesis
of the sickness problem. These studies are rich in factual

and normative events. Despite the fact that in some of these studies the investigators have suggested remedial measures for overcoming the sickness phenomenon, these studies fail to provide an overall systematic approach to the problem. In the following paragraphs some of the important descriptive studies are reviewed.

The National Council of Applied Economic Research (NCAER, 1978), while reviewing the government policy on statutory control of cotton textiles for the period 1961-1975, reported that the price of raw cotton which is a major cost item in the cotton textile industry is not controlled. Further, the price index for cotton textiles has not kept pace with the price index of raw cotton. The system of controlled pricing for textiles worked well only when the overall profits were good and the losses in the production of controlled cloth could be absorbed by more profitable product ranges. The textile industry suffered considerable losses on account of the production of controlled cloth which was sold to the consumers at subsidized rates. The assumption on the part of the policy planners that this loss could be passed on to the consumers of finer qualities of cloth was not always correct. The NCAER (1978) findings showed that the demand for finer varieties of cloth was elastic and that it was not always

possible to pass on the loss sustained in the sale of controlled cloth to the non-controlled finer varieties without affecting sales. The result was a squeeze in profits. This resulted in tardiness in the much needed modernization in the industry and many mills developed symptoms of sickness.

The Reserve Bank of India,in one of its reports (RBI, 1978),pointed out that the textile mills have not been in a position to attract enough public confidence for equity participation. This has resulted in heavy dependence for cash requirements in the form of government soft loans. Moreover, the RBI study stipulated that the vicious circle of low reserve and surplus, and higher borrowings would further lead to the lowering down of reserves and surpluses.

Piramal (1981) has observed that the acute state of sickness in the organized sector of the cotton textile industry could be attributed to the following factors:

(1)   Soaring costs of production on account of high price of cotton fibre.

(2)   Rising wage bills with dearness allowance linked to the cost of living index.

(3)   Increase in the costs of stores, machinery, spares, fuels, dyes and chemicals.

(4)   Heavy losses incurred on production of controlled
        cloth by the industry.

(5)   Fall in the offtake of cloth due to the reduced
        purchasing power of people and substantial production
        of rayon and synthetic yarn and mixed yarn fabrics.

(6)   Low average labour productivity.

(7)   Adverse government policies resulting into growing
        burdens on the financial position of the mills.

(8)   Freezing of the weaving capacity of the organized
        sector through the introduction of Industries
        (Development and Regulation) Act, 1951, in order to
        facilitate the development of handlooms.

(9)   Old outmoded and worn out machinery used by the
        organized sector of the industry.

(10)   Low profitability ratios in the cotton textile
        industry as compared to other major industries.

        Piramal (1981) has also suggested the following
remedial measures to facilitate the recovery of the textile
units from sickness:

(1)   There should be a substantial reduction in the
        interest rates charged by the banks on the loans
        given to the textile mills.

(2)   There should be a moratorium or, at least,
       subsidizing the bank interest charges for a specified
       period till the unit recoups its health.

(3)   There should be term loans by banks or financial
       institutions to meet the working capital gap that
       has resulted on account of heavy losses incurred
       in the past.

(4)   There should be special loans sanctioned by banks
       to defray retrenchment compensation arising out of
       implementation of scheme of rationalization. This
       should be repayable in instalments from out of the
       savings of rationalization measures, to enable
       mills to rationalize their complement to achieve cost
       reduction.

(5)   Wages should be productivity - oriented. The
       dearness allowance should be a fixed quantum for one
       full year based on the average of the Consumer Price
       Index of the preceding year. This will enable the
       enterprize to know its commitment to labour on this
       account in the coming year to design its production
       program, taking into account the change in situation.

(6)   The existing tax structure relating to textiles
       should be streamlined so as to remove anti-productive
       and anti-growth anomalies and inequalities.

(7)   The textile industry should be freed from un-
       necessary controls and regulations so that entrepre-
       neurs can concentrate on production.

Further more, Piramal (1981) has argued that sick-
ness in the textile industry was being unfairly ascribed to
bad and inefficient management. On the other hand, it has
really been largely the outcome of historical factors and
policies of the government.

The National Productivity Council in its report
(NPC, 1981) on sick textile mills of West Bengal and Madhya
Pradesh reported that there has been a fear psychosis
amongst the promoters of textile mills because of the
uncertain policies of the government as well as availability
of better avenues of investment. The latter has resulted
into a flight of capital from the organized sector of the
industry. Further, the non-availability of equity capital
has made the mills solely dependent on soft loans from
financial bodies and nationalized banks. In another study
by the same organization (NPC, 1976), it was observed that
the gross capital formation rate of cotton textile mills
lie below 10%, while the rate of divident paid by a large
number of these mills has been higher than the rate of
profitability. This is in sharp contrast to the general
practice followed by the industrial sector where the rates

of dividend declared are by and large lower than the rates of profitability. Further, the non-availability of the mill's own resources in the form of equity formation has resulted into borrowings which in the long run have constituted a major source of drain in the total profits of the mills.

Vijayanagar (1981) has examined the impact of taxation on cotton textile industry. He has brought out various anomalies in the excise duty and sales tax structure. According to him, the industry paid Rs. 28 crores in excise duties and sales tax in 1951 on a production of 5,100 million metres of cloth and 625 million kg. of yarn. The industry paid, in 1976, Rs. 180 crores on the output and Rs. 152 crores on the inputs of 8,160 million meters of cloth and 1,000 million kg. of yarn making a total tax liability of Rs. 332 crores per annum and showing a rise of as much as about 10 times. This incidence has further increased since then, worsening the financial position of the industry in general and a large number of weaker mills in particular. He has suggested the adoption of Value Added Tax (VAT) system of taxation. Pending the adoption of such a system, the existing tax structure should be streamlined so as to remove anti-productive and anti-growth anomalies and inequalities. Specifically, the following taxation reforms are suggested for textiles:

(1)   The classification of fabrics into 40's and above
        for excise purpose should be abolished and replaced
        by ad valorem duties.

(2)   Yarn duty also should be made ad valorem and in
        the case of the composite industry, the ad valorem
        yarn duty should be merged with the ad valorem fabric
        duty.

(3)   The excise exemption advantage imparted to the
        handloom products should not be allowed to be
        nullified by placing in the market controlled cloth
        at artificially deflated prices.

(4)   There should be a drastic reduction in multiple tax
        rates and simplification of the tax structure.

        Poddar (1981) has examined the performance of the
industry from the view point of export of Indian cotton
textiles. He observed that the share of Indian industry
towards the export of cotton textile has been around 0.30
per cent to 0.50 per cent of the global total over the past
several years. Table 3.1 gives the figures on India's
share in the total world exports of textile from 1951 to
1975. The current export figure is estimated at 0.50 to
0.60 per cent. Despite the fact that the Government of
India has been putting in concerted efforts to encourage
export by the Indian industries, our share percentage in the

world textile market has been dwindling over the years.
Poddar (1981) has also examined causes for this decline.
He has claimed that the loss of export has been due to
the non-availability of modern machines to the textile mills
resulting in low quality and high cost product. He has
advocated the need for modernization in textile industry
to improve the quality of the product and to bring down
the costs, so that the competitiveness of our textiles in
the international market is not lost in terms of price,
quality, etc.

Vidyarthi (1982) and D'Souza (1982) have also
substantiated the conclusions of Poddar (1981). While
D'Souza (1982) stressed on the need of modernization for
improving the productive efficiency and quality and reducing
the manufacturing cost. Vidyarthi (1982) strongly recommended
that modernization would not only help the mills to achieve
better financial performance, but at the same time would
create a culture among the workmen and the staff for the
proper use of modern machines.

Rao and Girde (1982) have dealt with productive
efficiency aspects of spinning and composite mills. They
concluded that the profitability of the cotton textile
mills over the past 15 years was only 8 to 9 per cent as
against 12 to 14 per cent in other industries. Further,
considerable gap has existed between the actual and desired

efficiency. They have attributed this to poor utilization of available productive capacity in spinning and weaving mills. Their analysis has also indicated that the spinning and weaving mills, on an average, are under-utilized by 20 per cent and 14 per cent, respectively. Thus, they recommended fuller utilization of the current installed capacities rather than going in for total modernization which is considered to be prohibitively expensive.

Lalbhai (1982) has examined the economic problems faced by the cotton textiles industry. He suggested that, on account of consumer resistance, consumers spending on non-essential or non-food items (specially cloth) has gone down. With the results, the industry has now been compelled to sell its product at a price lower than the expected ones. This has acted as a major stumbling block towards the generation of working capital and introduction of rehabilitation and modernization programs. Upholding the findings of Rao and Girde (1982), he pointed out that the present sickness of the industry could also be attributed to the under-utilization of capacity. In his opinion, the discreminatory government policies over the past 25 years to encourage more labour intensive handloom and powerloom sectors have also contributed significantly towards the present malady of the textile industry. He specifically pointed out the following discriminatory measures: (1)

governmental subsidy to the non-organized sector in the
form of cash; (2) exemption from excise duty, sales tax
etc.; (3) ban on the installation of new looms since 1950;
and (4) the imposition of production restrictions.

In addition to the aforementioned literature, a
number of articles and newspaper reports have appeared
on this subject over the years. Most of these reports
reflect somewhat conflicting viewpoints of either mill
owners, worker, government, or consumers. The reports are
found to be lacking objectivity and, on occasions, confounding.
Hence, only a list of these publications is contained in the
Bibliography.

3.2. Inter-firm Comparison Studies

The inter-firm comparison studies primarily deal
with the evaluation of the status of mills on various
aspects of performance employing certain well established
criteria. The inter-firm comparison literature is presented
under two main criteria: (1) based on productivity indices;
and (2) based on financial ratios. In productivity oriented
inter-firm comparisons, the researchers have compared a
set of indices which reflect factors such as production
rate, machine utilization, extent of modernization, the
degree of labour employment, etc. In financial inter-firm
comparisons, financial ratios like profitability ratio,

current liability to assets ratio, total liabilities to assets ratios, are compared. Since financial indices are more readily understood and reflect the measures in terms of money denominations, these were found to have better acceptability by the economists and financial institutions.

3.2.1. Inter-firm Comparison using Productivity Indices

In the early sixties, the three textile research associations (ATIRA, BTRA and SITRA) evolved suitable indices of productivity which permitted inter-firm comparisons of their member mills. Since then several modifications have been made mainly (a) to render these indices capable of direct interpretation, and (b) to make the indices diagnostic in nature, so that the main index and the sub-indices could indicate the areas of deficiency.

Productivity basically is the output per unit input and is generally named after the kind of input. Considering the difficulties in measurements of inputs and outputs Sahu (1981) has considered it much more a concept rather than a realistic measure. However, in the textile industry, the productivity is conventionally measured considering the output in terms of the yarn or cloth produced, whereas input is the number of machine-hours or man-hours. A true measure of productivity will be one which is not affected by factors such as percentage of production on carded or

combed counts, range of count spun, type of fibres used as raw material, etc. (Girde, 1977). According to Girde, the productivity measure should reflect and get affected by factors like production rates, machine efficiency, extent of modernization, degree of rationalization of labour, quality of raw material, etc. He has further observed that the productivity indices used for the inter-firm comparisons should be independent of the factors that relate to what the mill manufactures, and it must account for all the factors that relate to how the mill manufactures. Such a productivity measure makes the direct comparison of any two mills feasible and meaningful irrespective of whether these mills have the same product mix or not. Moreover, such productivity measures have facilitated the comparison of mill performance over the years disregarding the possible changes in its product-mix. SITRA (1979) has evolved the practice of measuring productivity by deter-mining it in comparison to a standard performance.

The three textile research associations (ATIRA, BTRA and SITRA) have developed their respective productivity indices in such a way that these indicate the productive efficiency of a mill with respect to that of a hypothetical standard mill. According to these associations, a standard mill assumed to be manufacturing the same product in the same quantities as the mill that is being assessed. However,

in the standard mill, all the aspects of manufacture such as type of machinery, technical parameters, machine efficiency, and labour allocation are assumed to be at a predetermined standard level. The standard fixed for various types of machines reflect the state of technological development in the textile industry, while the standards for production and labour are so chosen that these are achieved by at least 20 per cent of the mills. The standard mill, therefore, though hypothetical is said to be a real unit that can exist in practice and, hence, is not merely a theoretical concept. It follows that a mill which does not have standard machinery at every stage of its processing can not hope to achieve the level.

Jaiswal and Jani (1975) studied gross output per worker (i.e. labour productivity in physical terms), value of the gross output per worker (i.e., labour productivity in value terms) and value added by manufacturer (VAM) per worker for cotton textile industry. They used 'Census of Indian Manufacturers' (CIM) and 'Annual Survey of Industries' (ASI) figures from 1949 to 1966, as the primary data source. The objective of the study was to have a general picture regarding the progress of the industry. Following are some of the important conclusions of their analysis:

(a)   Physical output in quality as well as in value
        terms has increased more or less throughout the
        period 1949 - 1966.

(b)   The share of raw materials in gross output has been
        roughly 61% on an average.

(c)   The share of labour (i.e., wages and salaries) in
        gross output has been about 24%.

(d)   Labour productivity in value added terms has
        remained constant over the years under consideration.

(e)   The value added by manufacture (VAM) per man/day
        has been on an average Rs.6.20 (at constant price
        taking 1949 = 100).

(f)   For every rupee of investment in this industry,
        the value added by manufacture, on an average, has
        been about Rs. 0.63 per year.

(g)   Labour productivity in value terms has remained more
        or less constant from 1956 to 1966. Further, it
        has been below par.

Soma Sunder (1977) examined the causes of variation
in productivity between 107 member mills of SITRA and the
extent to which cost differences can be attributed to such
a variation. He suggested a new measure "productivity cost
differences" which enabled him to evaluate the individual

and combined effect of labour and machine productivity costs.

Girde (1977) has developed a set of indices concerning salient aspects of man-machine productivity. He observed that, in any profit-making organization, minimizing the costs is essentially relative to what unit has been doing in the past and what other mills are doing currently. This calls for an assessment of performance of a mill, both over a period of time and in comparison to other mills.

Rao and Girde (1981), while employing the ATIRA system of indices for examining the current status of productivity in spinning and composite mills, have suggested that the most important factors from among those within the direct control of mill management affecting the profitability are the machines and labour productivity in spinning and weaving departments. Consequently, mills which have been at low level of productivity in spinning and weaving have suffered from much greater financial losses whenever the parity between sales price (of yarn/cloth) and raw material prices (mainly cotton) have become adverse.

Modi (1982) has used BTRA system of indices to perform inter-firm comparison of BTRA member mills. One noteworthy aspect of his work is the emphasis on labour

productivity and its improvement in BTRA mills.

Productivity indexing systems developed by ATIRA, BTRA, and SITRA, have been considered by Modi (1982), Ratnam (1976), Raja Manickam (1979) as good measures of man and machine productivity. However, the usage of these measures for over-all health status of a mill could not be over-emphasized. Both labour and machine productivity indices are influenced by count spun and there is always a great variety of product mix on each machine. Although this has been resolved by reducing the production to a common count of 20's or 40's, the quantity factor rather than the value consideration has been the sole criteria for the development of all such indices. Ratnam (1976) while developing the productivity measures for SITRA mills has opined that the overall performance measure which is generally given by profitability could not be judged through productivity ratios alone. There are so many successive activities which transform the physical output into a profitable venture. Some of these are the ability of management to decide for a correct product mix, utilization of various resource inputs, the quality of input material, and the right type of technology for the product. The usage of these indices has been limited to indicate to the management how far under the given conditions machines, equipments, and labour are not meeting the expected standards.

The expected standard value criteria have also been an issue of serious debate. Due to the ad hocism involved in the evaluation of standards, the productivity indices computed by the research associations are of little use for health status determination.

3.2.2. Inter-firm Comparison Using Financial Ratios

Financial ratio analysis has become a matter of textbook exposition. Lev (1974) and Kuchhal (1976) have dealt with it at length. Financial institutions and investors use financial ratios for evaluating the performance of a firm. The use of ratio for inter-firm comparisons or for a single firm over time does not involve a statement of categorical cause-effect relationship because the phenomenon can seldom be segregated on that basis (Pranjape, 1982). There are several variations of financial ratios that one finds being used in literature for intra-firm as well as for inter-firm comparisons. Basically, there are four categories of such ratios: (a) Profitability ratios, (b) Short term solvency (liquidity) ratios, (c) Long term solvency ratio, and (d) Efficiency turnover ratios.

The main emphasis in the usage of financial ratios is to find out the one which best discriminate between sick and non-sick mills. Several studies have shown that there is no single ratio which could be taken as the best

predictor of sickness, but several ratios in combination, may provide best predictive ability.

ATIRA, BTRA and SITRA carried out a joint financial performance survey for their member mills to bring out the causes for the wide disparity in return on capital and profits among mills. The survey report (SITRA, 1979) considered 162 mills comprising of 73 composite mills and 89 spinning mills. The inter-firm comparison is based on return on the capital employed, profits per spindle, cost of production in relation to sales turnover and various financial ratios. Specifically, five financial ratios, viz., current ratio, liability to net worth, reserves to paid up capital (%), turnover/capital and debts to suppliers as % of turnover were considered. The profit and loss accounts and balance sheets for the period 1976-77 were used as the basic sources of data. In order to make comparison between composite and spinning mills, the installed capacity for composite mills was worked out in terms of equivalent spindle by using the following relationship.

$$Z = X + 50Y$$

Where X and Y are the installed capacities in terms of spindles and looms for the composite mill and Z gives its equivalent spindles.

The survey, besides pointing out the causes for variation in return on capital and profits per spindle, has brought out the following findings based on inter-firm comparison of financial ratios.

(1)   The return on capital before depreciation averaged about 13% for spinning mills and only about 5% for composite mills in 1976-77. The general level of return on capital in the textile industry is found to be inadequate i.e., 10 to 20% during the past five years as against a minimum return of 25% required in order to meet depreciation, interest rate and bonus, and dividend. This is because an average mill has to pay on the capital employed about 7% for interest charges — 5% for depreciation, 7.5% for taxes, and 5.5% for bonus and dividend. It has been reported that during 1976-77 which happened to be a recession year, only about one-fifth of the spinning mills and 10% of the composite mills had a return higher than 25%.

(2)   In spinning mills a low capital did not necessarily lead to lower return, but in composite mills low capital invariably resulted in losses. Also in mills employing fixed assets of Rs.700/- per spindle and above, the return was somewhat lower. Mills having fixed assets of over Rs.400/- per spindle (spinning mills) and Rs.300/- per spindle (composite mills) recorded very high profits, while

mills having fixed assets of less than Rs.100/- per spindle (spinning mills) and Rs.150/- per spindle (composite mills) invariably incurred losses.

(3)   Fairly high correlation was observed between profit and return on capital both for spinning and composite mills. The correlation coefficients for spinning & composite mills were found to be 0.82 and 0.92, respectively.

(4)   The profit per spindle before providing for depreciation and interest is on the average only Rs.60/- for spinning mills and Rs.35/- for composite mills. The profitability varied very widely between mills. The difference between the best and worst case being as high as Rs.350/- per spindle.

(5)   In high profit spinning mills, the high profit is due to a combined contribution more or less in equal proportion of low raw material cost relative to the yarn selling price, and high sales turnover (Rs.2000 - per spindle) and to a lesser degree by low wages (10%). In high profit composite mills low raw material cost (45%) is the major contributing factor for high profits. These mills also had lower wages (18%) and had a higher turnover (Rs.1900 - per spindle). While the high profit spinning mills had the same average count as other spinning mills, the high profit composite mills had finer average count (40s) and produced more sophisticated fabrics.

(6)   The raw material cost is, on the average, 67% of
the turnover for spinning mills and about 50% for the
composite mills. Whereas in spinning mills the average
raw material cost varied from 60 to 75% for a difference in
average count from 75 to 25; In the composite mills, the
raw material cost is found to be independent of the average
count.

In light of the above findings, SITRA (1979) has
recommended 'norms' for mills to be declared 'sick' and
has also suggested conditions under which mills could earn
good profits. Some of the broad indications for a mill to
be sick are:

(a)   Fixed assets are lower than Rs.150/- per spindle
        for the composite mills and Rs.100/- per spindle
        for the spinning mills.

(b)   Salaries and wages share to turnover is greater than
        24% for the composite mills and 18% for the spinning
        mills.

(c)   Sales turnover lower than Rs.600/- per spindle
        per year.

In order to earn good profits during normal trading
conditions, a mill should have:

(i)   Fixed assets of more than Rs.300/- per spindle in
        composite mills and Rs.400/- per spindle in spinning
        mills.

(ii)   Salaries and wages relative to turnover lower than
        18% in composite mills and 12% in spinning mills.

(iii)   Sales turnover higher than Rs.1500/- per spindle
        per year.

Srivastava and Kumaria (1980), while dealing with
the usage of financial ratio, have observed that the
financial ratios which are usually based on the published
financial statements of the companies can be easily
manipulated through creative accounting. There is, therefore,
a need to look for other characteristic parameters on long-
term basis which when combined with selected financial
ratios may give discrimination between the sick and healthy
units and may help in predicting sickness in industries.
They have suggested that combination of financial,
operational, and technical variables might prove to result
in a better indicator for differentiating between sick and
healthy units.

Gupta (1983) performed an inter-firm comparison
study on 38 mills considering 25 profitability based ratios.
The sample of 38 mills comprised of both sick and non-sick
textile units. Data for the period 1962-64 was used to

evaluate the various ratios. Gupta has reported that of all the profitability ratios the following two ratios resulted in least classification error.

(a)   Earning before interest and depreciation to sales ratio.

(b)   Operating cash flow to sales ratio.

The classification error was found to be 11 to 13 per cent for 1962 and only 8 per cent for 1964.

Gupta (1983) has also carried out an inter-firm comparison study using 31 balance sheet ratios. His sample was the same as used for profitability based ratios study. Each of the balance sheet ratios measured, directly or indirectly, one of the following four characteristics of the mill:

(a)   Strength of equity base,

(b)   Liquidity,

(c)   Intensity of asset utilization, and

(d)   Asset condition.

The study revealed that none of the balance sheet ratios classified the sick and non-sick mills as well as the profitability- based ratios. However, of the various balance sheet ratios considered, least classification error was observed for the following:

(a)   Net worth/debt ratio including both short-term
        and long-term debt;

(b)   All outside liabilities/tangible assets ratio.

        Gupta (1983) has opined that the financial factors
by themselves rarely cause sickness but they do cause
both embrassment and aggravation of sickness when opera-
tional performance becomes unsatisfactory from other causes.
Hence, in order to understand sickness and also to
recognize its early symptoms, one has to look at the
operating statement rather than at the balance sheet.
There are, however, still quite real risks and obstructions
arising from excessive debt. One is that the debt begins
to grow at compound interest if a company fails to make
profits to cover even the interest changes. Gupta finally
pleads in favour of a single joint index, considering all
relevant indices conjointly. However, he fails to suggest
any viable approach so that any composite indexing system
for identification of sickness can be developed.

3.3. The Prediction Studies

        In the literature most of the predictive models
reported deal with the issue of corporate failure. The
predictive models provide early warning signal of probable
failure and can enable the management and investors to
take preventive measures. Predicting corporate failure is

important from both the organization and social points of view. In U.S.A. and Western countries the term corporate failure is synonymous with bankrupty. Bankruptcy in reality is the culmination of failure. In the true economic sense the failure might have occured several years prior to bankruptcy proceedings. The bankruptcy stage is normally too late for the initiation of any meaningful corrective action. According to Gupta (1983;p.5) the bankrupt/non-bankrupt is not very relevant in the Indian context since the failure of an enterprize in India usually culminates - nowadays at least, not in a bankruptcy petition but in the taking over of the company by the government.

The several models developed and reported in the literature have generally followed one of the two routs. These are failure prediction by univariate (Single variable) models, and prediction by multivariate models. In the multivariate models several variables are used simultaneously in the prediction process. In the following paragraphs prediction models of both the types are reviewed.

3.3.1. Univariate Prediction Models

Beaver (1966) was among the first to develop univariate predictive models for corporate failure. He examined the predictive power of 30 different financial ratios and

examined their relative efficiency to predict failure upto
5 years in advance. His study excluded the consideration
of nonaccounting data in failure prediction. The most
significant findings of his work was that the ratio 'cash
flow/total debt' was the best predictor of failure since
it showed the least percentage of error in prediction for
sampled firms. The sample consisted of 79 firms that
failed and 79 non-failed firms, selected by the paired
sample technique. Lev (1974), using Beaver's sample,
tested the predictive power of the various decomposition
measures applied to financial statements. In the financial
statements the decomposition analysis a total, such as
total assets, total consumer's expenditure, or total
portfolio investment, is regarded as given, and the changes
over time in the allocation of this total to the various
subunits is studied. The average decomposition measure
of failing firms were found to be substantially larger than
those of the non-failing ones. A dichotomous classification
test showed that the balance sheet decomposition measure
had a lower misclassification percentage error than all
financial ratios tested. However, cash flow to total
debt ratio slightly out performed the decomposition
measure.

3.3.2. Multivariate Prediction Models

In multivariate approach to failure prediction there is simultaneous consideration of several indicators in the prediction process. Altman (1968) followed this approach and combined several financial ratios into a single index using the Multiple Discriminate Analysis (MDA) technique. He developed a discriminate model to distinguish between bankrupt and non-bankrupt firms prior to actual bankruptcy. He considered 22 accounting and non-accounting variables in various combinations as predictors of failure. He used a sample consisting of 33 paired manufacturing firms where industry and size were used as the matching criteria. Altman's (1968) final discriminant function was based on 5 financial ratios. He claimed that the final discriminate function provided one-year-prior prediction with 95% accuracy. However the classification error jumped to 28% when data 2 years before bankruptcy was considered.

Meyor and Piffer (1978) have developed a linear regression model for the prediction of bank failures. They used dependent variable as dichotomous data (i.e., a dummy value-taking zero for solvent banks and 1 for failed ones), while the independent variables were various financial statements measures. This statistical technique yielded results quite similar to those of the discriminant analysis used by Altman (1968).

The prediction studies of Beaver (1966), Altman (1968) and Lev (1974) dealt with bankruptcy as a specific event of failure. However, as pointed out earlier, the bankrupt/ non-bankrupt classification is not of much relevence in the Indian context since the failure of an enterprise, results in the taking over of the failed mill by the government.

Padmanabhan (1974) has proposed a multiple linear regression model to relate the profitability ratio (gross profit/total capital employed) with several causal variables. The causal variables considered in the model were size of the mill (total net assets), capacity utilization, technology (production per spindle per shift), labour complement (number of persons per 1000 spindles), product. pattern (percentage of cloth processed) and finances (current ratio). He developed the model considering data on 85 mills for the period 1960 to 1968. He observed that the size, capacity utilization and product pattern are not the significant predictors of the profitability index. Further, he suggested a norm for declaring a mill sick. According to him a sick mill is one which in any period of 3 successive years has an average gross profit which is 5% or less of the total capital employed.

Pranjape (1980) has developed a multiple discriminant model using data from 54 pairs of sick and non-sick textile

mills. Firstly, he selected a group of 54 mills which had fallen sick during the period 1962 – 1975. The sample contained mills declared sick at different time periods. For each sick mill a matching pair of good mill was selected. Initially, a set of 16 ratios were used for performing the discriminant analysis. Data for the year in which the mill has fallen sick was used. He performed the analysis on various combinations and finally selected four ratios on the basis of best discriminating characteristics. The four ratios finally selected were: (1) raw material consumed to sales (2) inventory to current assets ratio, (3) retained earnings to total assets ratio, and (4) earning before interest and taxes plus depreciation to total liabilities.

Pranjape's work is the only work of significance concerning prediction of sickness in Indian textile mills. However, following shortcomings are observed in his approach.

(1) The selection of sick mills for the sample which had fallen sick at different time periods does not stand on sound logic. Gupta (1980) observes that the strength of a firm lies in its having a strong relative position within its industry. By the same logic, a weak relative position reflected by ratios increases the chances of failure. Therefore, by taking the data on sample mills at different points in time the relative position of the mills

at a given time could not be ascertained and used to assess the chances of failure or success of the mill.

(2)   The methodology adopted by Pranjape (1980) to drop some of the indicators like gross-profit to sales ratio, current assets to current liability ratio, net worth to fixed assets ratio, does not seem to be proper as in the financial literature these ratios are considered to be some of the very important attributes reflecting the performance of a firm. Factor analysis could have been used by the author for identifying important attributes on the basis of their loadings on the underlying factors. The author has not made any attempt to exploit this approach probably due to the non-availability of good computing facility.

3.4. Conclusion

The large number of descriptive studies available on the causal system of sickness phenomenon in Indian textile mills can be of considerable utility to develop general understanding of the problem. The facts and figures brought out in these studies can be meaningfully utilized to interact with the field people for the identification of factors which influence the performance of a textile mill.

The productivity indices developed by ATIRA, BTRA, and SITRA for inter-firm comparison are of little use for assessing

the overall status of a mill since these indices are
based on hypothetical standards. Further, different
criteria are used by the three research organizations for
the normalization of various counts produced by the member
mills. No attempt has been made to carry out inter-firm
comparison based on productivity indices - of all the
mills in the country.

Most of the predictive models available in the
literature deal with bankruptcy prediction based on
financial ratios. Though the financial ratios are
considered to be good indicators of a firm's performance,
at a given point in time yet their usage to establish
the health status of a mill in the overall context can not
be over-emphasised.

In the following chapter, the causal elements
effecting the performance of a textile mill have been
identified using the descriptive studies reviewed in this
chapter as one of the important inputs.

CHAPTER IV

INTERPRETIVE STRUCTURAL MODELLING OF SICKNESS PHENOMENON
IN COTTON TEXTILE INDUSTRY

In this chapter we identify the interacting elements
which influence the performance of a cotton textile mill.
The causal system is represented in the form of an
Influence Diagraph(ID). The ID is further analysed to
develop a hierarchical structure of the causal system,
called an Interpretive Structural Model (ISM).

4.1. Structural Identification and Modelling

The concept of structural identification is a well
established engineering design practice and several
graphical methods like block diagrams and flow charts are
used for this purpose. However, the societal problems like
industrial sickness are generally large and extremely complex
in nature and there is inadequacy of information describing the
structure, composition and properties of the system. Further,
it would take prohibitively too much effort and time to
acquire exhaustive information about the system. Most of
the real life systems are only partly observable, partly
controllable, partly cognizable and as a consequence only
partly predictable from the stand point of control centres
(Forrester,1965,p.15)Therefore, the structural problems of

such systems are often dealt with either subconsciously
or implicitly. The structural aspects are generally
combined in such a way that the consciously designed
structure is not sufficiently separate from substance.
Better insight into the problem and control mechanism is
developed through human involvement. The inculcation of
more insight becomes possible by presenting a picture of
the conceptualized system to specialists and system
analysts regarding the interactive aspects of the problem
under consideration and an interactive picture which is
called either a Digraph Model (Robert, S., 1976), Influence
Diagram (Coyle, 1977) or Influence Digraph (Roberts, E.B.,
1976) is developed. The Influence Digraph (ID) is analysed
for identifying the hierarchical structure of the causal
system and the results are portrayed in the form of an
Interpretive Structural Model (ISM). It is not necessary
that one succeeds in developing the ID and ISM of the
complex system in one attempt. The whole process is an
iterative one. The information available in the literature
and the opinion of practitioners as well as decision makers
are used throughout the iterative development of the model.
Finally, a model which reflects the real life situation
and is acceptable to all concerned is evolved.

Interpretive structural modelling is a methodology
for improving, expanding and communicating mental models

of the relationships between elements in complex systems. The methodology transforms the mental model into a structural format which enables the modeler to communicate a perception of the system to others. In essence, the interpretive structural modelling process transforms unclear, poorly articulated mental models of system into visible and well defined models. The ISM approach has its basis in graph theory, set theory, mathematical logic and matrix theory. Some of the areas where this approach has been successfully applied are: energy supply and demand (Sage, 1977), ecological balance problems (Roberts, S., 1976), study of pattern of transportation in urban areas (Coyle, 1977), manpower planning (Sage, 1977), etc. In all these applications ISM has been advantageously applied to identify the interactive elements for realizing the basal subsystems of the problem and to represent the real life phenomenon in a canonical form.

4.2. Development of ID for Sickness Problem in Cotton Textile Industry

The development of an ISM for the sickness phenomenon in cotton textile industry has been developed in following steps.

1. Identification of interacting elements

2. Construction of ID of the interactive elements

3.   Development of ISM from the Adjacency Matrix
        obtained in step 2.

4.2.1. Identification of Interacting Elements

The several descriptive studies reviewed in
Chapter III have provided excellent background for under-
standing the sickness phenomenon in cotton textile industry.
Additional inputs on the problem were obtained through the
process of discussions with the officials of the following
organizations:

1.   Textile research associations, viz., ATIRA, BIRA
        and SITRA.

2.   Special sickness monitoring cell of the Reserve
        Bank of India, Bombay.

3.   Office of the Textile Commissioner, Bombay.

4.   Indian Cotton Manufacturers Federation (ICMF), Bombay.

Further, the information obtained from the senior
managers of the various textile mills has been advantageously
utilized for the identification of various interacting
elements. Finally, a set of 28 interacting elements
representing the causal system of sickness in cotton textile
mills was identified. The sickness of a textile unit can
lead to the closure of mill followed by governmental
takeover. Thus, in all, there were 31 interacting elements

including the three elements reflecting the effect of the other 28 elements. A list of the interacting elements is given in Table 4.1. Each element is identified by an identification number. Further, the connectivities of the elements have been listed. A brief explanation for each of the 31 interactive elements is given below:

1. <u>Technical Obsolescence and Old Machinery</u>: Technical obsolescence and old machinery are considered to be important contributors towards the present state of affairs in the cotton textile industry. Practically, 60 per cent of the installed capacity belongs to mills which are 30 to 40 years old. The worn out machinery and outmoded techniques have resulted in the industry's inability to meet the strict export requirements, thus resulting in low exports. Further, technical obsolescence has led to low capacity utilization, high production costs, low production of textile and inadequate maintenance (RBI, 1976).

2. <u>Labour Problems</u>: The 1980 ICMF Annual Survey has identified labour problems as one of the most important contributors in aggrevating the sickness condition of cotton textile mills. During the period of conflict, the production is hampered and the overall performance of the mill is affected due to go-slow and other tactics adopted by the employees. The ever spiralling inflation has

TABLE 4.1 : Interacting Elements and their Connectivities.

Element No.	Description	Connectivities
1	Technological obsolescence and old machinery	7,9,19,25,27
2	Labour problems	11,25,26,27, 28
3	Low financial position	5, 9, 28, 29, 30
4	General inflation	2, 11, 13, 21, 23
5	Delayed payments	2, 26, 28, 31
6	High price and low quality product	13, 15, 19
7	High production cost	25, 26
8	Natures vagaries	18, 22, 24
9	Inadequate maintenance	7, 26, 27
10	Government cotton policy	18, 24
11	High input cost	7
12	Poor quality cotton fibre and low yield	6, 11
13	Low sales volume	3, 25
14	Outstanding liabilities	3, 26
15	Low consumer demand	13
16	Government credit policy	3
17	Government cotton development effort	12
18	High cotton fibre cost	11
19	Low export demand	13
20	Government production control policy	28
21	High fixed cost of equipments	7
22	Low cotton fibre production	24
23	High agricultural input cost	24
24	Cotton growers pressure	18
25	Low production of cotton textile	28
26	Additional credit requirements	28
27	Low capacity utilization	25
28	Low overall perfomance	29
29	Sickness of the mill	30
30	Closure of the mill	31
31	Government takeover of the mill	-

considerably eroded the mill workers earnings, causing
labour disputes in wages. Delayed bonus payments and non-
implementation of wage accords have also contributed to
labour problems. As a consequence of these problems there
has been low overall performance, low production, low
capacity utilization and high input cost to the mills.
All this has created need for more credit requirements for
an affected mill in order to fulfill its obligations towards
labour (ICMF, 1980).

3. <u>Low Financial Status</u>: Due to heavy dependence of the
industry on external sources of capital, a large share of
gross profits has been fleeing away from the industry in
the form of interest payments (NPC, 1975). The capacity
of the industry to plough back profits has been almost
negligible and, therefore, for sustenance the industry has
to indulge in increased borrowings. High outstanding
liabilities, low sales volume and additional credit
requirements are some of the important contributors to the
low financial status of textile mills. As a result of low
financial status, there has been inadequate maintenance and
replacements of old and worn out machinery, and delayed
payments to the creditors and employees. According to
Piramal (1980), the low financial status of sick textile
mills could be attributed to the unfavourable credit policies

of the government. ICMF in its Annual Survey of 1980
has also claimed that the policies of the government
regarding allocation of public funds to private mills have
been unfavourable and many deserving sick mills have been
deprived of soft loans on account of the governmental
policies.

4. <u>General Inflation</u>:   The prevalent inflationery trends
have made considerable erosion into the cost structure
of individual textile mills. Further, it has been
responsible for aggravating the labour problems and has
resulted in increased cost of agricultural inputs, high
equipment costs and low consumer demand (due to high priced
low quality textile products).

5. <u>Delayed Payments</u>:   As a result of retrogression in
financial position, the mills find it difficult to meet
their obligations to the employees and creditors. The
aggrevated delayed payments affect the overall performance
as well as influence the cotton price quoted by the suppliers
under the effect of non-settlement of overdue bills.

6. <u>High Priced and Low Quality Product</u>:   High production
cost and poor quality of cotton available in the country
have been the main contributors for high priced and low
quality product. The high price and low quality of the

product has adversely affected the export potential as
well as the internal demand. As such, the total sales
volume of the textile produced by the mills has been affected.

7. High Production Cost: As a consequence of high input
cost, high fixed cost, inadequate maintenance and
replacement of worn out machinery, and technical
obsolescence, the cost of production of cotton textile
has been high as compared to the price market offers for
the product. This has resulted in pressure for additional
credit requirements.

8. Natures Vagaries: Cotton fibre production, like
any other agricultural production in India, is largely
dependent on favourable natural climate. Failure of
monsoon, untimely rains and many other such natural vagaries
have, on several occasions, hampered the overall production
of cotton. The reduced production affects cotton price
and production of cotton fibre. Moreover, the reduced
production of cotton prompts the growers to pressurize
the government for fixing higher prices for their produce
and to provide various kind of subsidies.

9. Inadequate Maintenance: Technical obsolescence and
low financial position of the mills have resulted in
inadequate maintenance of plant and machinery. Consequently,

this has resulted in low capacity utilization and high production cost of cotton textiles (Lalbhai, 1980).

10. Government Cotton Policy: In order to protect the interests of the cotton growers and to check the speculative trade practices followed by certain sections of the cotton textile industry, the Government of India has established an autonomous corporation called the Cotton Corporation of India (CCI). The CCI operates as a corporate body and markets about 50 per cent of the total production of different grades of cotton fibre produced in the country. The corporation also fixes and controls the price- line of the cotton fibre. However, on several occasions, the corporation has faced heavy pressures from the cotton growers for the fixation of higher prices for their produce (Poddar, 1980).

11. Higher Input Cost: The major cost components in cotton textile production are: cost of raw material i.e., cotton fibre, labour cost, and other overheads. Generally inflation has resulted in the increase of these costs. Further, low yield and poor quality cotton produced in the country has contributed its share to high input costs (Piramal, 1980).

12. <u>Poor Quality and Low Yield Cotton</u> :   The quality
as well as per hectare yield of cotton fibre in India
is not at all comparable to the prevalent international
standards. Mostly the fibre produced is of short and
medium staple variety. Poor quality cotton fibre has
resulted in high wastage as well as inferior quality yarn.
High wastage has caused the price of yarn to go up. The
high priced and low quality fibre available to the mills
has encumbered their ability to export at competitive
rates.   In order to improve the quality of cotton fibre and
obtain higher yield, the government has introduced several
cotton development programs (Piramal, 1980).

13. <u>Low Sales Volume</u>:   Over the years, there has been
steep fall in the demand of cotton textile both in the
domestic and export markets. High price and poor quality
of the product are the two main reasons responsible for
low overall sales volume. Consequently, the mills have
been forced to lower down their production to avoid losses
on the unsold stocks. Reduced volume of overall sales has
evidently affected the financial status of the mills
(NCAER, 1979).

14. <u>Outstanding Liabilities</u>:   Since 1950-51 the industry
has relied heavily on external sources for the generation

of additional capital. The proportion of borrowings in
the total net capital employed by the industry has
steadily increased from 22.8 per cent in 1950-51 to about
47.8 per cent in 1972-73 (NPC, 1973). This percentage has
further increased during the past decade. As a consequence,
the mills have been in a precarious financial position and
even have to borrow money to pay for the outstanding
liabilities and always require additional credit.

15. Low Consumer Demand: Inflation in the price of
essential commodities, mainly food, has greatly eroded the
home consumer's spendings on cloth. Further, the high
priced and low quality product has resulted in "consumer
resistence" to purchase cotton textile. Consequently, the
consumer demand has dwindled which has affected the sales
volume of cotton textile (Lalbhai, 1980).

16. Government Credit Policy: All the major banks in
India were nationalized in the year 1967. These nationalized
banks operate under strict governmental surveillance.
Evidently, the soft loans which become available to the
textile industry are in accordance with the guidelines set
by RBI. Specifically, the funds for textile industry are
channelized through IDBI which looks after the nursing
program for weak textile mills. Mills, as such, do not have
any control over the policy except to mobilize public

opinion through ICMF or other like organizations. The policy is framed in the larger interest of the country by setting priorities in the allocation of public funds for various developmental programs. As such, this element has influenced the financial status of mills, which have since long lost their self equity raising capacity (NPC, 1973).

17. <u>Government Cotton Development Efforts</u>: The Government has set up various agencies to develop high yielding and long staple varieties of cotton fibre. These agencies have been making concerted efforts to overcome the predicament of poor quality and low yield of the cotton fibre (NCAER, 1979).

18. <u>High Cotton Price</u>: A disproportionate increase in the prices of raw cotton in relation to prices of cotton textile has adversely affected the condition of the industry as a whole. High cotton price is influenced by the general inflationary tendencies, delayed payments, natures vagaries, cotton growers pressure for higher prices for their produce and government cotton policy. As cotton fibre is the basic raw material for textile industry, high cotton fibre cost means higher cost of the cotton textile (Piramal, 1980).

absorb the difference between the actual cost of production and the control price for sale fixed by the government. Naturally, the mills distributed the losses on account of the production of control cloth over other varieties of cloth produced by the mills, resulting in higher price tag for these varieties. The high price tag attached to these varieties enhanced the phenomenon of "consumer resistance". The total offtake of cotton textile by the consumers got affected forcing the mills to lower down their production. By and large, it is believed that the government textile control policy has contributed significantly towards the low overall performance by the cotton textile industry from 1971 to 1980 (Poddar, 1980).

21. <u>High Fixed Cost</u>:   The general inflationary trends have been responsible for the increased cost of equipments and installations over the years. Any capital investment in lieu of replacements or modernization of equipments and machinery is to be realized in the form of fixed cost which forms an integral part of the cost of production (Gulrajani, 1982).

22. <u>Low Cotton Production</u>:   Low volume of cotton fibre produced as a result of nature's vagaries prompts the cotton growers to demand higher prices for their produce (NPC, 1981).

23. <u>High Agro Input Cost</u>:   In keeping with the general inflationary trends the prices of various agricultural inputs, viz., fertilizers pesticides, etc., and wages of agricultural labour have gone up. In order to compensate these higher input costs, the cotton growers have always pressurized the government to fix higher price for their produce (NPC, 1976).

24. <u>Cotton Growers Pressure</u>:   The cotton textile industry is primarily an agro-based industry. Most of its problems have origin in the performance of agricultural sector as a whole. The area covered for cotton crop depends on the input cost for the cultivation of cotton vis-a-vis other agricultural crops. The cotton crop is highly susceptible to fluctuations in the market as compared to food grains. Further, there is a tendency on the part of the farmers to switch over to other cash crops like food grains unless better price for cotton is assured. Cotton growers pressurize the government for the fixation of higher cotton price in order to obviate the effect of inflation and the additional price which other cash crops can fetch (NPC, 1976).

25. <u>Low Textile Production</u>:   Under-utilization of installed capacity, low sales volumes of textile product,

high production cost, technical obsolescence and old
machinery, and labour problems are the elements responsible
for low production of cotton textile. Low textile
production has contributed adversely to the overall
performance of mills (NCAER, 1980).

26. Additional Credit Requirements: Textile mills, by
and large, are unable to raise their own equity capital.
Outstanding liabilities; delayed payments, labour problems,
and high production costs are the elements which have
increased the credit requirements of the mills. High credit
requirements have upset the financial status of the mills
resulting in the low overall performance by individual mill
(Poddar, 1980).

27. Low Capacity Utilization: According to a survey
conducted by ATIRA, the average utilization in spinning
and weaving mills is 73 and 75 per cent, respectively
(ATIRA, 1979). Rao and Girde (1982) have claimed that
despite all the bottlenecks the textile industry is facing,
there is an achievable gap of 20 per cent in spinning
mills and 14 per cent in weaving mills. Low capacity
utilization primarily results from technical obsolescence
and old machinery, inadequate maintenance and labour
problems (NPC, 1976).

28. Low Overall Performance: Profitability measure and gross capital formation ratios are traditionally considered to be good measures of overall performance (Doraiswamy and Ratnam, 1981). In textile industry, profitability and gross capital formation rates are seriously affected by low textile production, labour problem, delayed payments to workers, creditors and suppliers, additional credit requirements and low financial status of the mills. Persistently low overall performance by a mill results in sickness (RBI, 1978).

29. Sickness of the Mill: Low financial status and persistently poor overall performance are two key elements contributing toward sickness of a mill. The sickness culminates either in the closure of the mill or its takeover by the governmental agencies.

30. Closure of the Mills: In the past, a number of textile mills have been closed down as a consequence of sickness and low financial status. The closure of mills have caused serious-economic problems.

31. Government Takeover of the Mill: The government takes over the management of a sick textile mill from its owners/promoters with a view to rehabilitating the mill and avoiding the serious socio-economic issues arising out

of the displacement of large workforce employed by
these mills. As pointed out earlier, the Government of
India established the National Textile Corporation (NTC)
for the management and control of takenover mills.
Subsequently, state level corporations were set up under
the NTC umbrella for this purpose.

4.2.2. Construction of Influence Digraph (ID)

In the previous section, a set of 28 interacting
elements of the causal system affecting the performance
of a cotton textile mill were identified. The resulting
effects of the causal system are reflected in terms of
the 3 elements representing sickness, closure, and
governmental takeover of the mills. Let P represent the
set of elements, p_i , i = 1, 2, ... 31. If element p_i
interacts with element p_j, these two elements are inter-
connected on the ID. The inter-connection is shown by a
directed line with + or - sign indicating enhancing or
inhibiting influence, respectively. Let E represent the
number of edges or lines connecting the elements in set
P. The elements in set P are ordered in the decreasing
order of their connectivities and numbered serially as
given in Table 4.1.

The connectivities amongst the various elements
are epitomized through an ID portrayed in Figure 4.1.
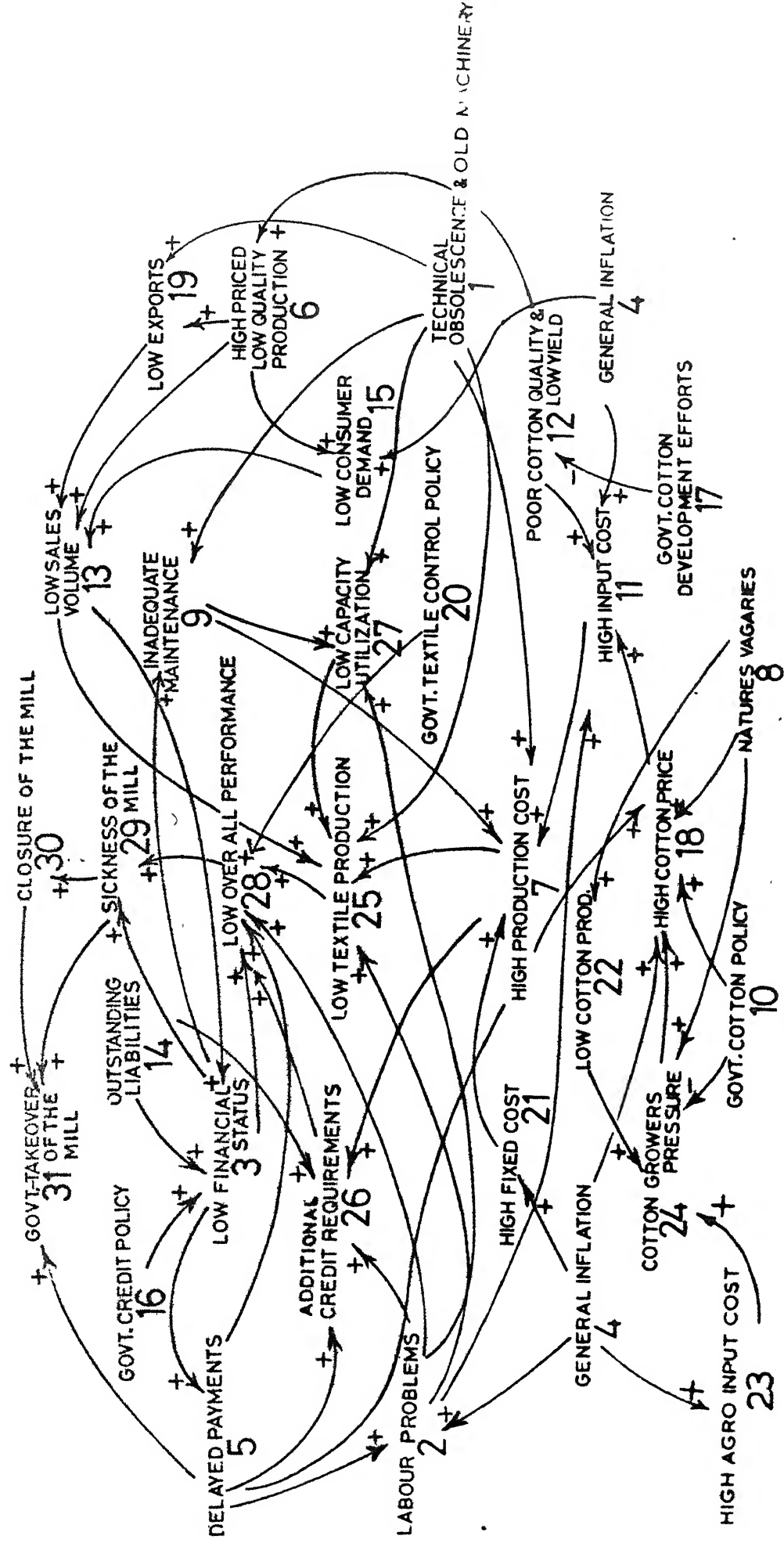
FIGURE 41. INFLUENCE DIGRAPH OF INTERACTING ELEMENTS LEADING TO SICKNESS, CLOSURE, AND GOVERMENT-TAKEOVER OF A COTTON TEXTILE MILL

The development of the ID is based on the following axioms:

(1)   The set of points P is finite and non empty.

(2)   The set of lines r (connecting two points) is finite.

(3)   No two distinct lines are parallel.

(4)   There are no loops.

The first two axioms are self explainatory. Axiom 3 shows that an ID is a relation, and axiom 4 restricts the relation to having no loops. Thus an ID is an irreflexive transitive relation (Sage, 1977). The development of an ID is an iterative process. Necessary corrective steps have been taken if either axiom 3 or axiom 4 was violated.

The ID given in Figure 4.1 has been obtained as a result of several iterations bringing in improvements in the ISM and ID at each iteration till the final ISM presented in Figure 4.17 was evolved.

4.3. Development of Interpretive Structural Model (ISM)

Binary Matrix Representation of ID Model: The causal system of sickness as portrayed through ID may be represented in the form of a binary matrix A, called the Adjacency Matrix corresponding to the elements p_i and p_j, the cell entry a_{ij} in the matrix A is either 1 or 0 depending

on whether $p_i R p_j$ or $p_i \bar{R} p_j$. The notation R represents
the relationship while $\bar{R}$ is the complement of R.
Another type of matrix called the "reachability matrix"
can be derived from the adjacency matrix by entering 1
as diagonal elements in the adjacency matrix. Figure 4.2
shows the adjacency matrix A for the ID shown in Figure 4.1.
The matrix A is of order 31.

Let S_H and S_V represent the horizontal and
vertical set of elements, 1 through 31, in the adjacency
matrix A. The elements in S_V influence the S_H elements
in accordance with the respective connectivities. An
element of S_V carrying all zero row entries is referred to
as the top level element. All top level elements consti-
tute a top level set. Similarly, an element of the set
S_H with all zero column entries is called the bottom level
element. This implies that a bottom set element is an
element in set S_H which reaches to other elements but no
other element of S_V reaches it. Similarly, a top level
element does not reach to any element of S_H. From Figure
4.2 it is observed that the bottom and top level sets
are [1, 4, 8, 10, 14, 16, 17, 20] and [31], respectively.
Since the hierarchies associated with the top and bottom
level sets are obvious, the elements belonging to these
sets are removed from A. The reduced matrix A', is next
partitioned to establish the structures associated with the

ELEMENT NUMBER, j

i \ j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0
2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
3	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
4	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	1
6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0
9	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
14	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
21	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ELEMENT NUMBER, i

FIGURE 4·2. ADJACENCY MATRIX OF INFLUENCE DIGRAPH (ID)

remaining elements. The matrix A' is of order 30 x 23.

The development of the ISM is attained through the following steps:

(1)   Partitioning of matrix A'

(2)   Development of minimum edge graph

(3)   Establishing the hierarchical ordering of the elements.

4.3.1. Matrix Partitioning:

The reduced adjacency matrix is partitioned to establish the embedded structure associated with the various elements. The information on the embedded structure is finally utilized for the development of an ISM. Sage (1977) has summarized five matrix partitioning methods which can be used to obtain the interpretive structural model from adjacency matrix. These methods are: relation partitioning, level partitioning, seperate part partitioning, disjoint and strong subset partitioning and strongly connected subset partitioning. These partitioning methods help in the identification of levels, cycles, disjoint parts, and reachability for any ordered pair of elements. The matrix A' is partitioned using the seperate part partitioning method. The partitioned matrices are further split into smaller segments such that each segment represents a group of elements of set P which are at the same level.

Each segment can be represented as a seperate digraph.
These digraphs are disjoint which when put together
constitute the structural model of P. Let D_1, D_2, ...,D_m
represent the m disjoint digraphs of P. Then

$$\overline{\Gamma}(P) = D_1, D_2, ... , D_m$$

The matrix A' is partitioned into two disjoint
matrices N and M such that they carry all the connectivities
in the upper triangular form and lower triangular form,
respectively. Both the matrices N and M are in canonical
form and are further subpartitioned such that each sub-
partitioned matrix represents either a single level
interaction or a column interaction. Subpartitioned
matrices are obtained by drawing horizontal and vertical
lines through each of the two matrices N and M in such a
way that all the null matrices are separated with minimum
number of lines.

The matrix A' which is of order 30 x 23 is
partitioned into two disjoint matrices N and M represented in
Figures 4.3 and 4.4, respectively. The matrices N and M
on further partitioning yield 7 and 3 submatrices,
respectively. The submatrices are labelled as N_1, N_2, ...
N_7 and M_1, M_2, M_3 , following the bottom right hand
corner sequential numbering scheme. Each of these submatrices
is represented in the form of a digraph. The submatrices of

ELEMENT NUMBER, j

	7	5	9	11	13	15	18	19	21	22	23	24	25	26	27	28	29	30	31
1	0	1	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0
2	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0
3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
4	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1
6	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
8	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
10	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

ELEMENT NUMBER, i

FIGURE 4·3. N MATRIX OF THE UPPER TRIANGULAR MATRIX OF A′

ELEMENT NUMBER, j

	2	3	6	7	11	12	13	18	25
4	1	0	0	0	0	0	0	0	0
5	1	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
9	0	0	0	1	0	0	0	0	0
11	0	0	0	1	0	0	0	0	0
12	0	0	1	0	1	0	0	0	0
13	0	1	0	0	0	0	0	0	0
14	0	1	0	0	0	0	0	0	0
15	0	0	0	0	0	0	1	0	0
16	0	1	0	0	0	0	0	0	0
17	0	0	0	0	0	1	0	0	0
18	0	0	0	0	1	0	0	0	0
19	0	0	0	0	0	0	1	0	0
21	0	0	0	1	0	0	0	0	0
24	0	0	0	0	0	0	0	1	0
27	0	0	0	0	0	0	0	0	1

ELEMENT NUMBER, i

FIGURE 4·4. M MATRIX OF THE LOWER
TRIANGULER MATRIX OF A'

N and M and the corresponding digraphs are given in Figures 4.5 through 4.11 and Figures 4.13 through 4.15, respectively.

4.3.2. Development of Minimum Edge Graph

The Warfield's Principle of Embedding (Warfield, 1973) is used to obtain the minimum edge graphs of N and M. According to this principle if an element p_i influences p_j and in turn p_j influences p_k while p_i also directly influences p_k, then the line joining p_i with p_k should be pruned as this interaction is assumed to be embedded into the structure via point p_j.

The digraph of N_2 is merged into the digraph of N_1 to obtain the minimum edge graph for N_1 and N_2. The minimum edge graph of N_3 is then merged into N_1 and N_2 to obtain the minimum edge graph for N_1, N_2 and N_3. This procedure is followed to obtain the minimum edge graph of N shown in Figure 4.12. As an illustration, let us consider the digraphs of N_1 and N_2 given in Figures 4.5(b) and 4.6(b), respectively. When these two digraphs are merged, Warfield's Principle of embedding, identifies the edges 3 $\longrightarrow$ 29 and 5 $\longrightarrow$ 31 (shown by dotted lined in Figure 4.6(c)) for pruning and are dropped. In order to conserve on space, only links of digraphs N_1 and N_2 are shown in Figure 4.6(c). However, the complete minimum

i \ j	24	26	28	29	30	31
14	0	1	0	0	0	0
20	0	0	1	0	0	0
22	1	0	0	0	0	0
23	1	0	0	0	0	0
25	0	0	1	0	0	0
28	0	0	0	1	0	0
29	0	0	0	0	1	0
30	0	0	0	0	0	1

(a)   SUBMATRIX N_1
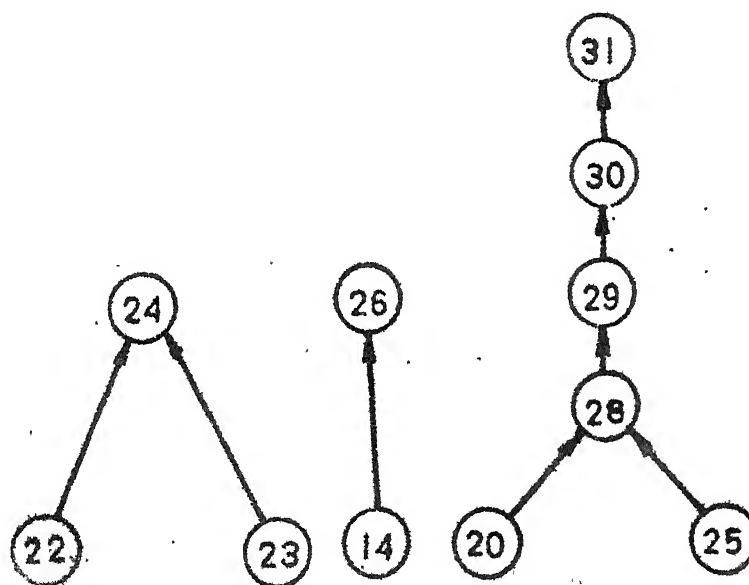
(b)   DIGRAPH

FIGURE 4·5. SUBMATRIX N_1, AND ITS DIGRAPH

j / i	28	29	30	31
2	1	0	0	0
3	1	1	0	0
5	1	0	0	1

(a)   SUBMATRIX N_2
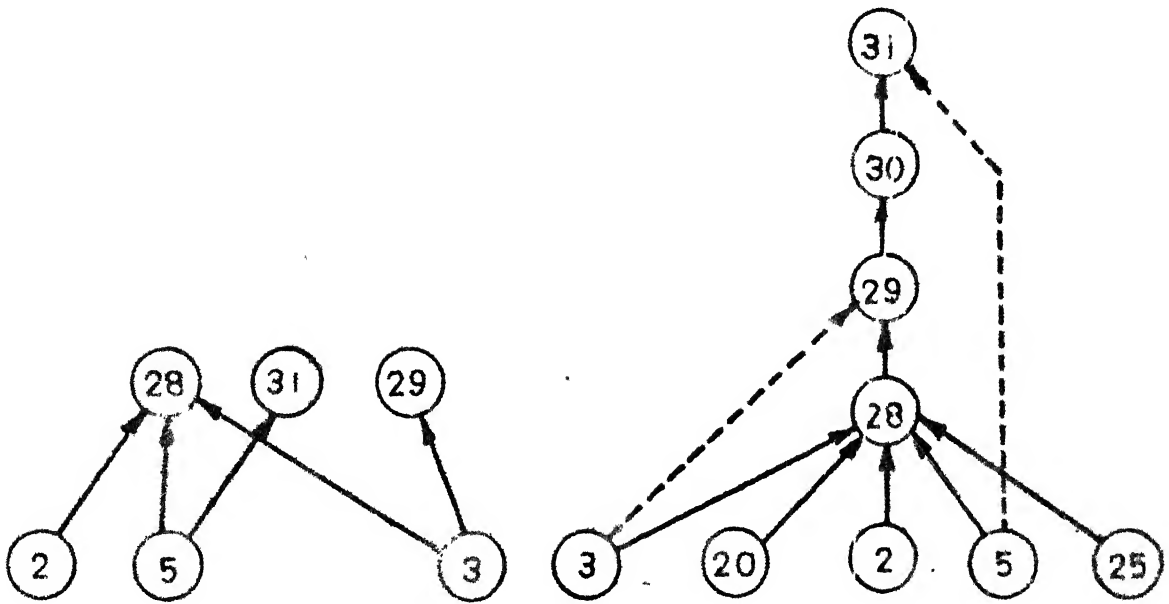
(b)   DIGRAPH

(c)   LINKS

FIGURE 4·6. SUBMATRIX N_2, ITS DIGRAPH AND LINKS WITH PRECEDING DIGRAPH OF N.
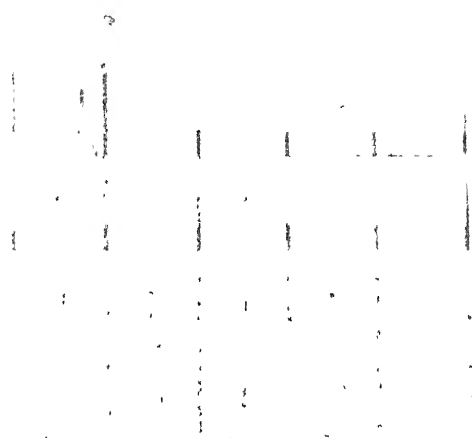
(a) SUBMATRIX N_3
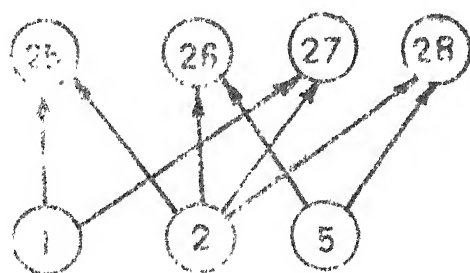
(b) DIGRAPH
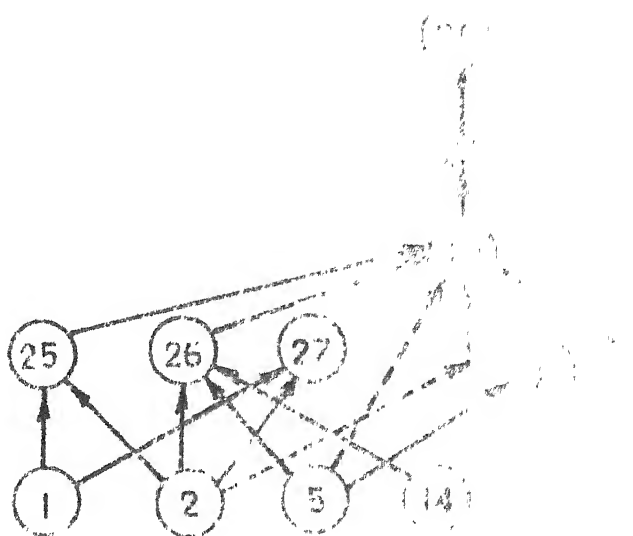
(c) LINKS

FIGURE 47. SUBMATRIX N_3, ITS DIGRAPH AND LINKS THE
PRECEDING DIGRAPH OF N

i \ j	24	25	26	27
7	0	1	1	0
8	1	0	0	0
9	0	0	0	1
10	1	0	0	0
13	0	1	0	0

(a) SUBMATRIX N_4
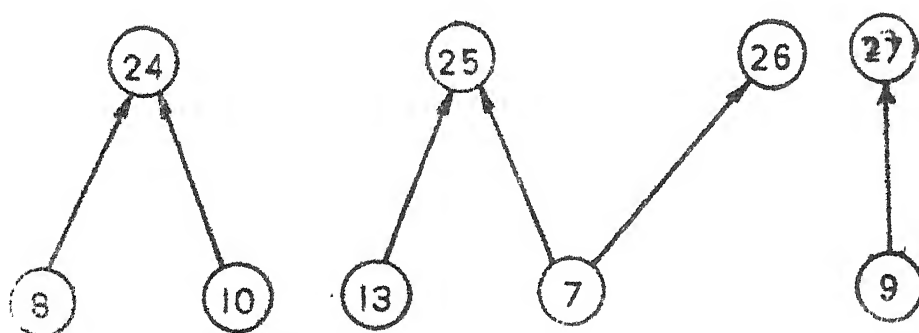
(b) DIGRAPH
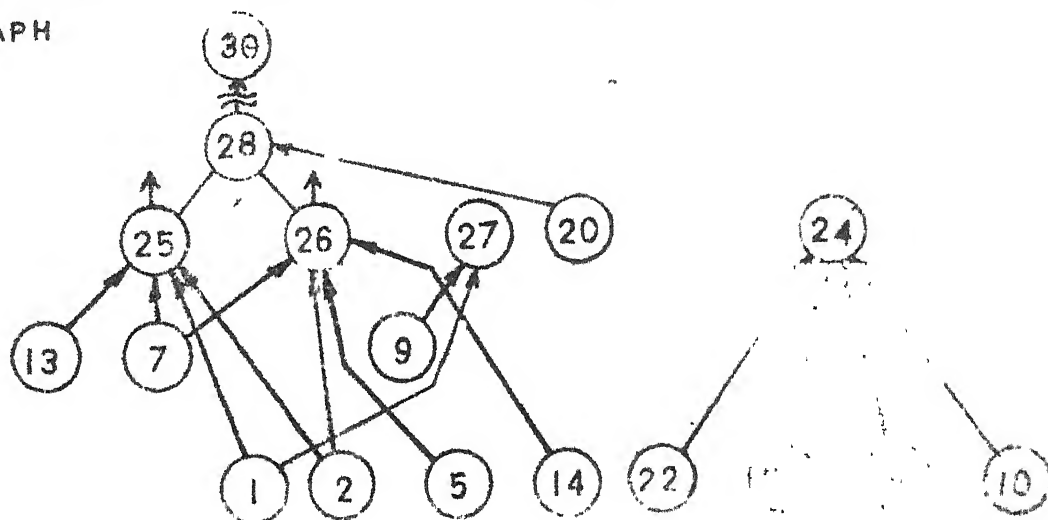
(c) LINKS

FIGURE 4·8. SUBMATRIX N_4, ITS DIGRAPH AND LINKS WITH
PRECEDING DIGRAPH OF N
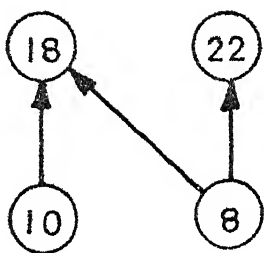
(a) SUBMATRIX N_5

(b) DIGRAPH
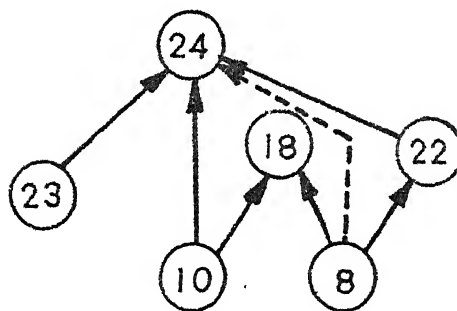
(c) LINKS

FIGURE 4·9. SUBMATRIX N_5, ITS DIGRAPH AND LINKS WITH PRECEDING DIGRAPH OF N.

i \ j	18	19	21	23
1	0	1	0	0
4	0	0	1	1
5	1	0	0	0
6	0	1	0	0

(a) SUBMATRIX N_6
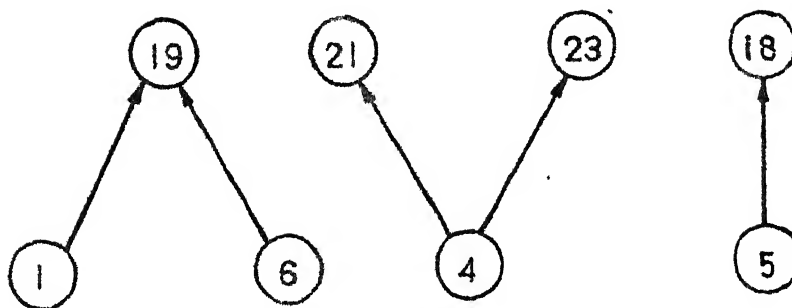
(b) DIGRAPH
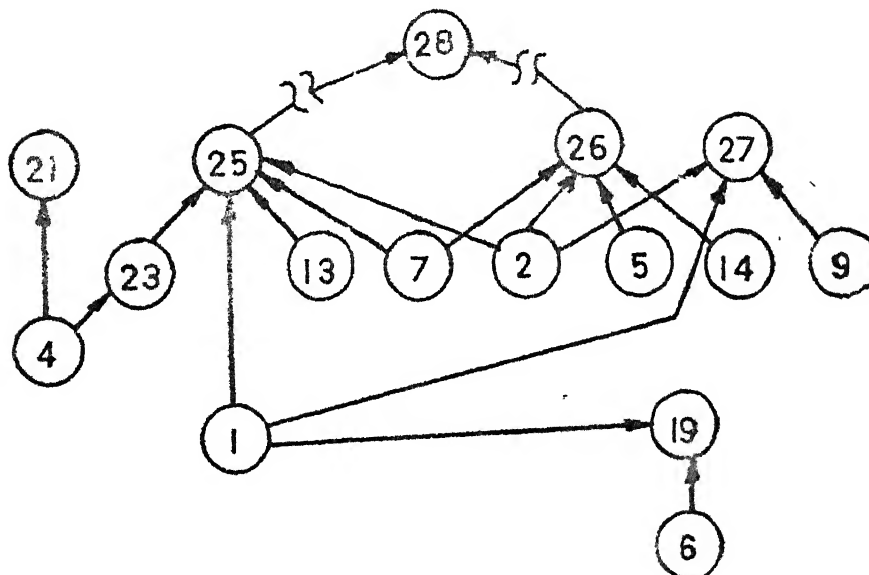
(c) LINKS

FIGURE 4-10. SUBMATRIX N_6, ITS DIGRAPH AND LINKS WITH PRECEDING DIGRAPH OF N.

4	0	0	0	1	1	0
6	0	0	0	0	1	1
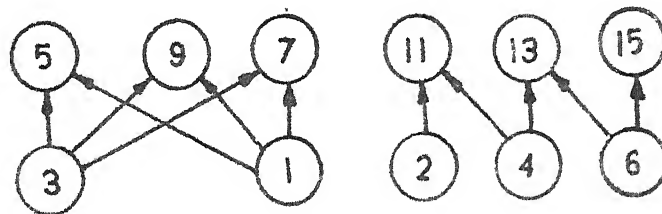
FIGURE 4·11. SUBMATRIX N_7 ITS DIGRAPH.
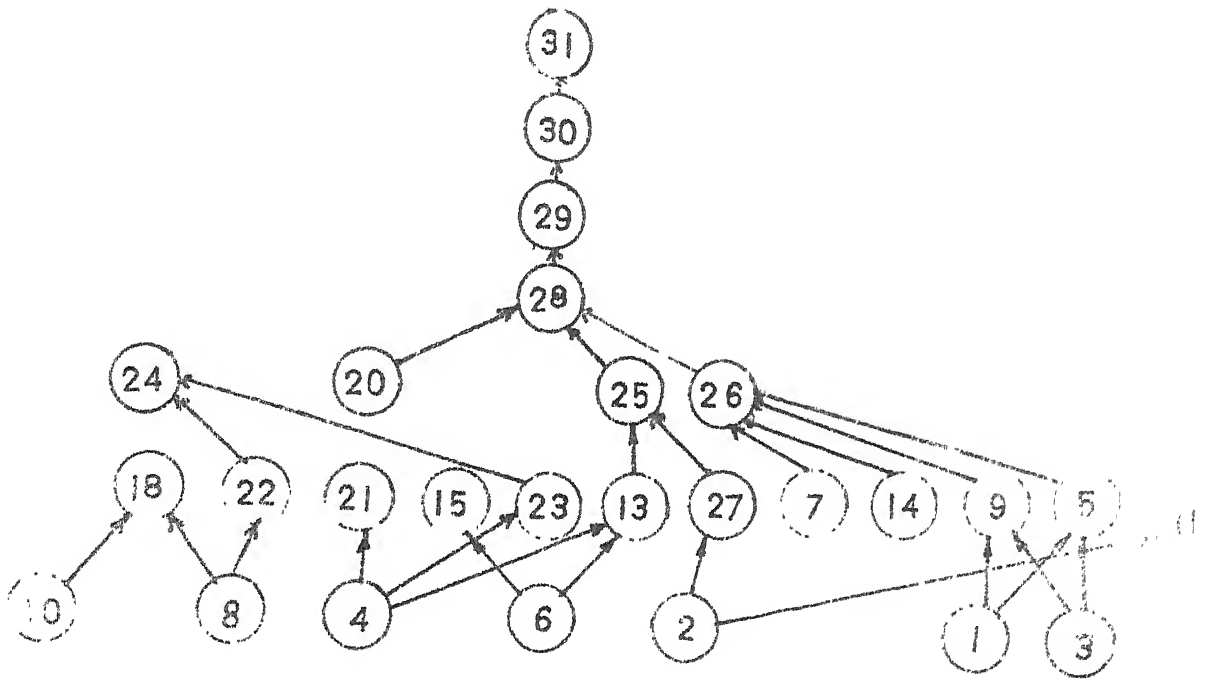
FIGURE 4.12. MINIMUM EDGE GRAPH OF MATRIX N.

edge graph of N_1 and N_2 would have the additional edges
$14 \rightarrow 24$, $22 \rightarrow 24$ and $23 \rightarrow 24$.

The minimum edge graph for the matrix M shown in
Figure 4.16 is obtained following the procedure used
for the development of minimum edge graph for matrix N.

The minimum edge graphs of N and M shown in
Figures 4.11 and 4.16 are next merged using the Warfield's
principle of embedding. However, such a merger does not
provide information on level at which the individual
element will appear in the final ISM.

4.3.3. Hierarchical Ordering of Interacting Elements

The hierarchy amongst the various interacting
elements is established using Warfield's Level Partitioning
method (Warfield, 1974, p.277). Let L_j represent the set of
elements at the jth level. Then

$$\Pi_1(P) = L_1, L_2, \ldots\ldots, L_e$$

Where e is the total number of levels identified. Let
$R(p_i)$ and $A(p_i)$ represent the sets of elements reachable
from element p_i and which reach the element p_i, respectively,
inclusive of the self reachability of element p_i. The
sets $R(p_i)$ and $A(p_i)$ are called the reachability set and
antecedent set, respectively.

	7	13	18	25
19	0	1	0	0
21	1	0	0	0
24	0	0	1	0
27	0	0	0	1

(a)   SUBMATRIX M₁
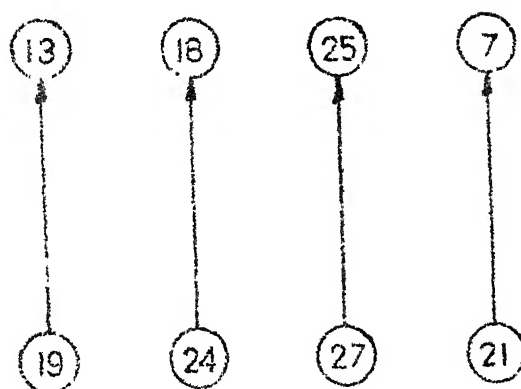
(b)   DIGRAPH

FIGURE 4·13. SUBMATRIX M₁ AND ITS DIGRAPH

i \ j	2	3	11	12	13
13	0	1	0	0	0
14	0	1	0	0	0
15	0	0	0	0	1
16	0	1	0	0	0
17	0	0	0	1	0
18	0	0	1	0	0

(a) SUBMATRIX M_2
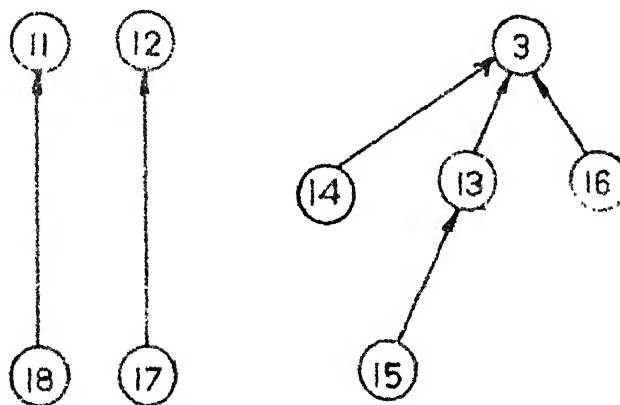
(b) DIGRAPH

FIGURE 4·14. SUBMATRIX M_2 ITS DIGRAPH

i \ j	2	6	7	11
4	1	0	0	0
5	1	0	0	0
9	0	0	1	0
11	0	0	1	0
12	0	1	0	1

(a)   SUBMATRIX M₃
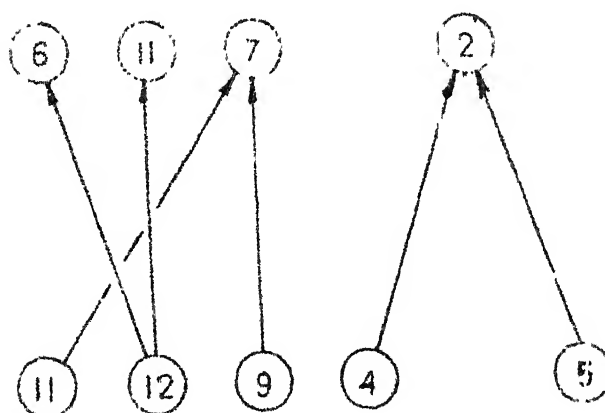
(b)   DIGRAPH

FIGURE 4.15. SUBMATRIX M₃ ITS DIGRAPH

DIGRAPH
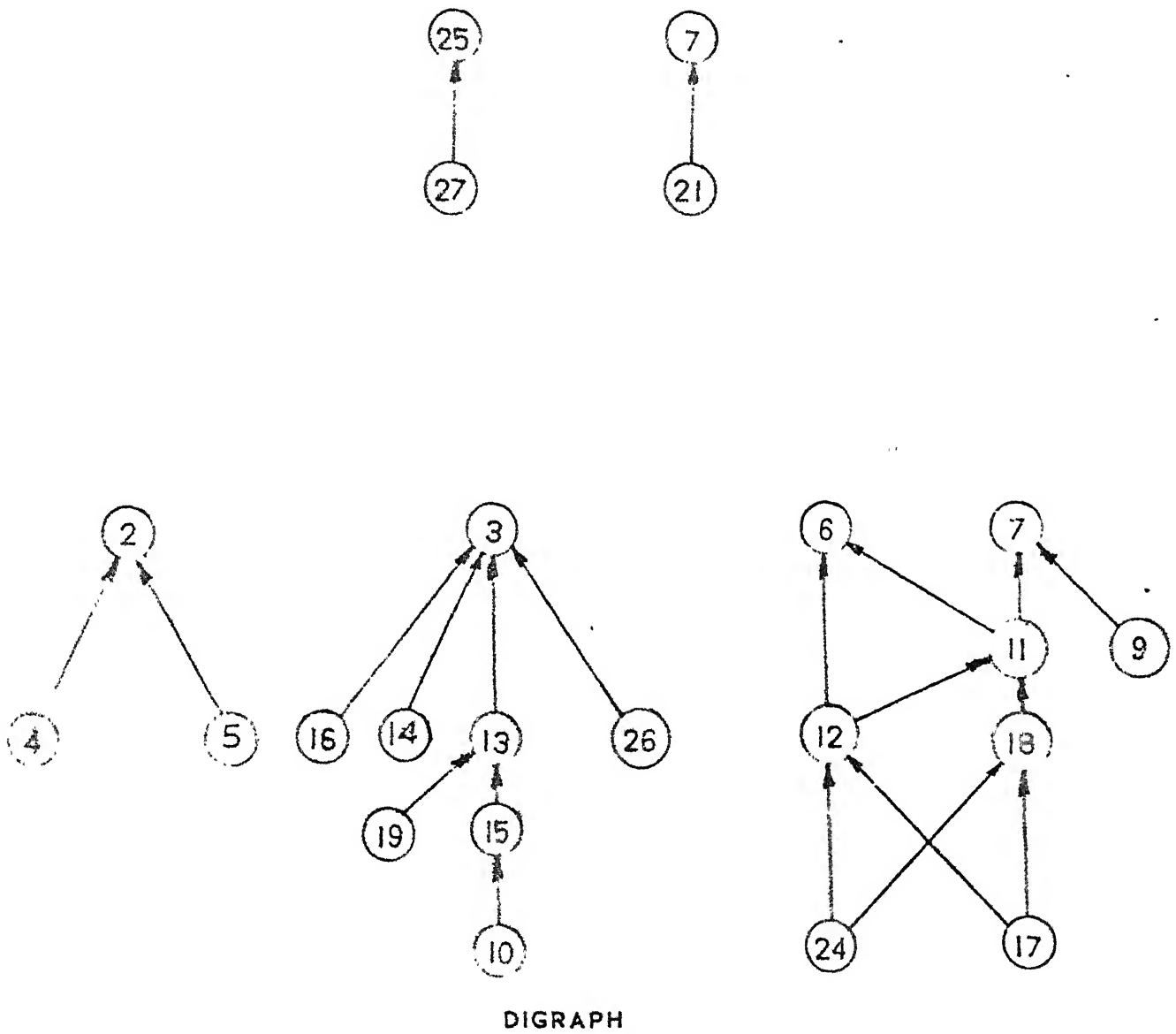
FIGURE 4·16. MINIMUM EDGE GRAPH OF MATRIX M.

An element p_i is a top level element if ‾(‵

$$R(p_i) = R(p_i) \cap A(p_i)$$

and is a bottom level element if

$$A(p_i) = R(p_i) \cap A(p_i)$$

Once the elements of top level are known, the element/s of the subsequent levels are identified by updating $R(p_i)$ and $A(p_i)$ progressively. The element/s of the previously identified level are deleted from $R(p_i)$ and $A(p_i)$ and again the top elements are identified and assigned to the next level. The iterative process is continued till all the elements have been assigned to appropriate levels. Mathematically, the iterative algorithm can be stated as:

$$L_j = \left\{ p_i \in P - L_o - L_1 - \ldots - L_j - 1 \;\middle|\; R_{j-1}(p_i) \right.$$

$$\left. = R_{j-1}(p_i) \cap A_{j-1}(p_i) \right\}$$

Where $R_{j-1}(p_i)$ and $A_{j-1}(p_i)$ are the reachability and antecedent sets determined considering the elements in $P - L_o - L_1 - \ldots - L_{j-1}$. Note that the 0th level is an empty set; $L_o = \emptyset$.

The above stated **Level Partitioning Method** is applied to our problem. Table 4.2 shows the sets $R(p_i)$, $A(p_i)$ and $R(p_i) \cap A(p_i)$ for $P - L_o$. An inspection of

TABLE 4.2 : Reachability and Antecedent sets for P-L$_o$.

Element p_i	Reachability Set $R(p_i)$	Antecedent Set $A(p_i)$	Intersection $R(p_i) \cap A(p_i)$
1	1, 19	1	1
2	2, 11, 27	2, 4, 5	2
3	3, 5, 9, 26	3, 13, 14, 16	3
4	2, 4, 15, 21, 23	4	4
5	2, 5, 18	3, 5	5
6	6, 15, 19	6, 12	6
7	7, 25, 26	7, 9, 11, 21	7
8	8, 22	8	8
9	7, 9, 27	3, 9	9
10	10, 15, 24	10	10
11	7, 11	2, 11, 12, 18	11
12	6, 11, 12	12, 17	12
13	3, 13	13, 15, 19	13
14	3, 14	14	14
15	13, 15	4, 6, 10, 15	15
16	3, 16	16	16
17	12, 17	17	17
18	11, 18	5, 18, 24	18
19	13, 19	1, 6, 19	19
20	20, 28	20	20
21	7, 21	4, 21	21
22	22, 24	8, 22	22
23	23, 24	4, 23	23
24	18, 24	10, 22, 23, 24	24
25	25, 28	7, 25, 27	25
26	26, 28	3, 7, 26	26
27	25, 27	2, 9, 27	27
28	28, 29	20, 25, 26, 28	28
29	29, 30	28, 29,	29
30	30, 31	29, 30	30
31	31	29, 31	31

this table indicates that $R(p_i) = R(p_i) \cap A(p_i)$ for element 31, which we identify as the top level element. Thus

$$L_1 = 31$$

For elements $\begin{bmatrix} 1, & 4, & 8, & 10, & 14, & 16, & 20 \end{bmatrix}$, since $A(p_i) = R(p_i) \cap A(p_i)$, they constitute the bottom level set. Next, we identify the elements of other levels. L_1 is deleted from consideration and revised sets $R(p_i)$, $A(p_i)$ and $R(p_i) \cap A(p_i)$ for $P - L_0 - L_1$ are determined. We observe that

$$L_2 = \begin{bmatrix} 30 \end{bmatrix}$$

As an illustration, in Table 4.3, we give $R(p_i)$, $A(p_i)$ and $R(p_i) \cap A(p_i)$ for $P - L_0 - L_1 - L_2 - L_3 - L_4$ for the identification of elements for L_5. We observe that for elements 25 and 26

$$R(p_i) = R(p_i) \cap A(p_i)$$

and, therefore, $L_5 = \begin{bmatrix} 25, & 26 \end{bmatrix}$

The application of the iterative algorithm yielded a total of 16 levels. Table 4.4 gives the allocation of interacting elements to the various levels.

TABLE 4.3 : Identification of L_5 ; $R(p_i)$, $A(p_i)$, $R(p_i) \cap A(p_i)$
for $P - L_o - L_1 - L_2 - L_3 - L_4$.

Element p_i	$R(p_i)$	$A(p_i)$	$R(p_i) \cap A(p_i)$
1	1, 19	1	1
2	2, 11, 27	2, 4, 5	2
3	3, 5, 9, 26	3, 13, 14, 16	3
4	2, 4, 15, 21, 23	4	4
5	2, 5, 18	3, 5	5
6	6, 15, 19	6, 12	6
7	7, 25, 26	7, 9, 11, 21	7
8	8, 22	8	8
9	7, 9, 27	3, 9	9
10	10, 15, 24	10	10
11	7, 11	2, 11, 12, 18	11
12	6, 11, 12	12, 17	12
13	3, 13	13, 15, 19	13
14	3, 14	14	14
15	13, 15	4, 6, 10, 15	15
16	3, 16	16	16
17	12, 17	17	17
18	11, 18	5, 18, 24	18
19	13, 19	1, 6, 19	19
20	20, 28	20	20
21	7, 21	4, 21	21
22	22, 24	8, 22	22
23	23, 24	4, 23	23
24	18, 24	10, 22, 23, 24	24
25	25	7, 25, 27	25 ⎫
26	26	3, 7, 26	26 ⎬ L_5
27	25, 27	1, 2, 9, 27	27 ⎭

TABLE 4.4 : Levels Assigned to Various Interacting
Elements.

Level No.	Elements
L_1	31
L_2	30
L_3	29
L_4	28
L_5	25, 26
L_6	27
L_7	7
L_8	9, 11, 21
L_9	2, 18
L_{10}	5, 24
L_{11}	3, 22, 23
L_{12}	13
L_{13}	15, 19
L_{14}	6
L_{15}	12
L_{16}	1, 4, 8, 10, 14, 16, 17, 20

4.3.4. Sketching the ISM and its Interpretation

The minimum edge connectivities obtained by merging the minimum edge graphs of matrices N and M alongwith the information on levels associated with various elements are utilized to draw the Interpretive Structural Model (ISM) portrayed in Figure 4.17. As pointed out earlier, the final ISM shown in Figure 4.17 has been obtained by iteratively improving upon the ID. Any cycling or ergodic chain detected has been eliminated such that the axiom of reflexivity is not violated. The following inferences are drawn from the ISM:

(1) Elements 31, 30 and 29 representing government takeover closure and sickness are at levels 1, 2 and 3, respectively. At level 4 we notice element 28 which represents low overall performance of a unit. This implies that prior to sickness the mills show serious deterioration in overall performance.

(2) At level 5 of the hierarchical structure, we observe elements 25 and 26 representing low textile production and credit requirements, respectively. This indicates that the low overall performance has prior symptoms indicated in the form of uneconomic production volume as well as non-availability of cash as working capital (additional credit requirement). The low production results
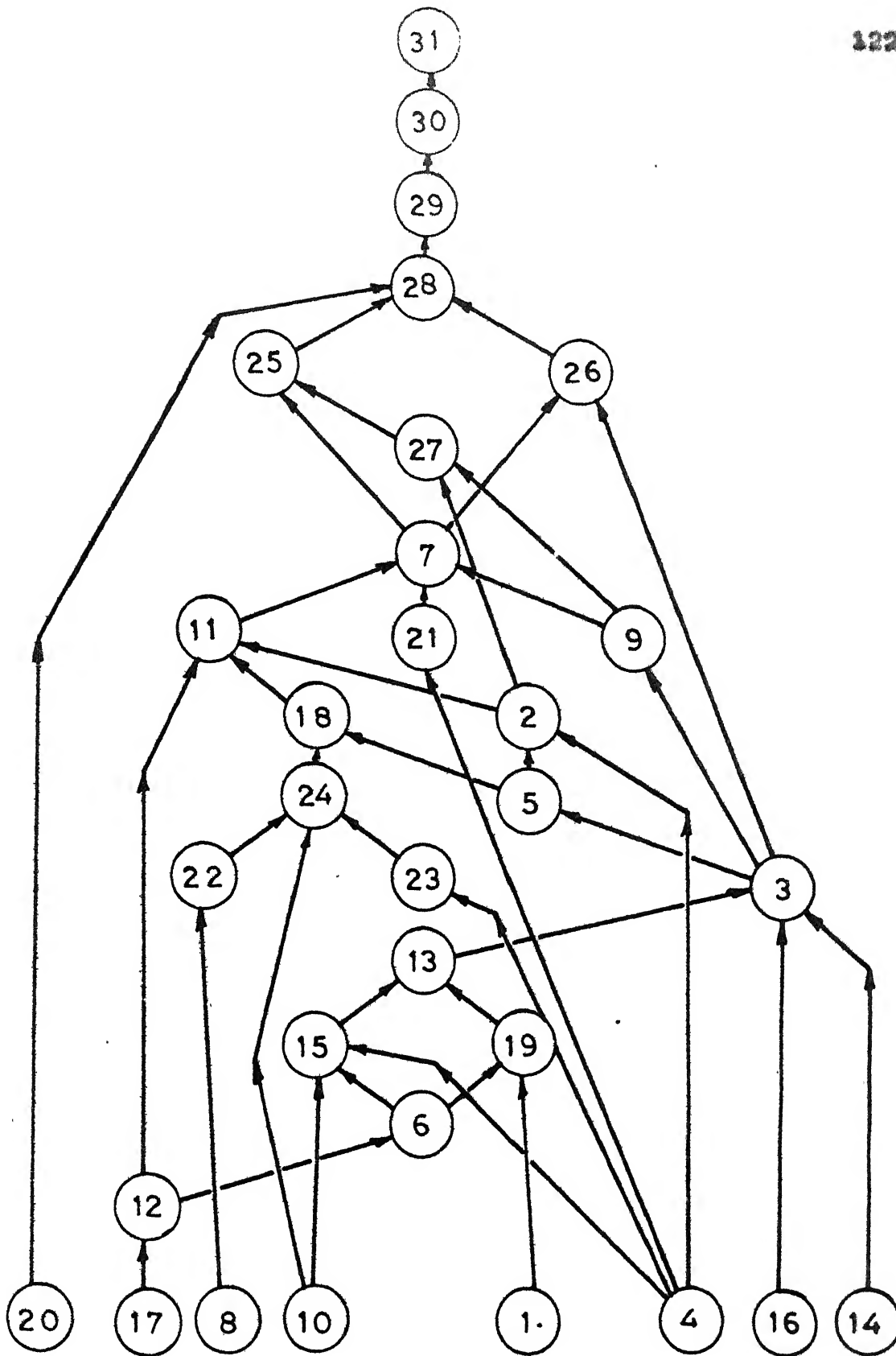
FIGURE 4·17. INTERPRETIVE STRUCTURAL MODEL OF SICKNESS PROBLEM IN COTTON TEXTILE MILLS LEADING TO CLOSURE AND — GOVERNMENT–TAKEOVER. (FOR ELEMENT CODE SEE TABLE 4·1)

as a consequence of low capacity utilization represented
by element 27 at level 6. Further, low production results
from high cost of production represent by element 7
which occupies level 7.

(3)   Level 8 carries elements 9, 11, and 21 representing
inadequate maintenance, high cost of inputs and high
equipment cost. These elements influence high cost of
production which occupies level 7.

(4)   Labour problems (element 2) and high cotton fibre
cost (element 18) occupy level 9 and influence High Cost
of inputs (element 11, level 8).

(5)   Elements 5 and 24 representing delayed payments and
cotton growers pressure, respectively, occur at the 10th
level of hierarchy. Delayed payments influence labour
problems (element 2, level 9) and cotton growers pressure
results in high cotton price (element 18, level 9).

(6)   Level 11 contains elements 3, 22 and 23 representing
low financial status, low cotton production and high cost
of agricultural inputs, respectively. Low financial
status causes additional credit requirements (element 26,
level 5), inadequate maintenance (element 9, level 8)
and delayed payments (element 5, level 10). Low production
of cotton and high cost of agricultural inputs influence
the attitude of cotton growers who tend to exert pressure

(element 24, level 10).

(7)   Level 12 consists of a single element, i.e., 13 representing low sales volume. Low sales volume influences the financial status (element 3, level 11).

(8)   Level 13 contains elements 15 and 19 representing low consumer demand and low exports of cotton textiles, respectively and result in low sales volume (element 13, level 12).

(9)   Level 14 comprises element 6 which represents high-priced low quality product which influences both the consumer demand and exports (elements 15 and 19, level 13).

(10)   Poor cotton quality and low yield (element 12) appears at level 15 and effects the product quality (element 6, level 14).

(11)   The bottom most level i.e., level 16 contains elements 1, 4, 8, 10, 14, 16, 17 and 20, representing technical obsolescence and old machinery, general inflation, natures vagaries, government cotton policies, outstanding liabilities of mills, government credit policy, government cotton development efforts, and government production control policy, respectively. Most of these elements are parametric in nature on which individual mill has very little control.

4.4. Identification of Basal Levers of Causal System

We now analyze the ISM given in Figure 4.17 to obtain relative contextual significance of each element in terms of its responsiveness to control. The responsiveness of an element p_i, CRI (p_i) is indicated by the ratio of the number of elements being affected by it, $NO(p_i)$, to the number of elements affecting it, $NI(p_i)$. Each element p_i also differs in its controllability salience as defined by the product of the control responsiveness index CRI(p_i) with its salience value $(NO(p_i) + NI(p_i))$, (Agrawal, 1976). Thus, the controllability salience of an element p_i, CS(p_i) is expressed as:

$$CS(p_i) = CRI(p_i) \left[NO(p_i) + NI(p_i) \right]$$

$$= \frac{NO(p_i)}{NI(p_i)} \left[NO(p_i) + NI(p_i) \right]$$

Now, from the ISM we observe that the elements 29, 30 and 31 represent sickness, closure and government take-over, which are the outcomes of the causal system in the indicated order. As such there is no need to determine the responsiveness of these elements to control. Further, the controllability salience for all the bottom level elements, viz., elements 1, 4, 8, 10, 14, 16, 17 and 20 would be infinite. This implies that these elements, which

TABLE 4.5 : Controllability Salience of Various Elements.

Element, p_i (1)	NO (p_i) (2)	NI (p_i) (3)	NO (p_i) ÷ NI (p_i) (4)	CS (p_i) = $\frac{Col.2}{Col.3}$ x Col.4 (5)
2	2	2	4	4
3	3	3	5	5
5	2	1	3	6
6	2	1	3	6
7	2	4	6	3
9	2	2	4	4
11	1	3	4	1.33
12	2	1	3	6
13	1	3	3	1
15	1	3	3	1
18	1	2	3	1.5
19	1	2	3	1.5
21	1	1	2	2
22	1	1	2	2
24	1	3	4	1.33
25	1	2	3	1.5
26	1	4	5	1.25
27	1	3	4	1.33
28	1	3	4	1.33

TABLE 4.6 : Ranking of Various Elements based on
Controllability Salience.

Rank	Element No. p_i	Description
1	5	Delayed payments
	6	High priced and low quality product
	12	Poor quality cotton fibre and low yield
2	3	Low financial position
3	2	Labour problems
	9	Inadequate maintenance
4	7	High production cost
5	21	High fixed cost of equipments
	22	Low cotton fibre production
	23	High agricultural input cost
6	18	High cotton fibre cost
	19	Low export demand
	25	Low production of cotton textile
7	11	High input cost
	24	Cotton growers pressure
	27	Low capacity utilization
	28	Low overall performance
8	26	Additional credit requirements
9	13	Low sales volume
	15	Low consumer demand

4.5. Conclusion

The ID and the ISM developed in this chapter
present the complex problem of sickness in the organized
sector of cotton textile industry in a canonical form.
The ISM reveals one discernible fact that the industry
is heavily controlled through governmental agencies as
5 out of 8 elements in the bottom level set are concerned
with government policies. Amongst the remaining interacting
elements delayed payments, high -priced low quality
product, and poor quality cotton fibre and low yield are
the most significant contributors towards the dismal
state of affairs in cotton textile mills. The other
interacting elements also contribute to the sickness
phenomenon according to the controllability salience values
depicted in Table 4.6.

The ISM shown in Figure 4.17 can be advantageously
used for the identification of measurable attributes
representing the short term (yearly) performance aspects
of textile mills.

CHAPTER V

SHORT TERM MILL PERFORMANCE ATTRIBUTES: IDENTIFICATION
AND BEHAVIOURAL PATTERN

This chapter presents the selection of a set
of attributes which represent the yearly performance of
a mill based on financial, economic and physical efficiency
considerations. The time series behaviour of a randomly
selected sample of mills for each of the attribute is
analyzed to draw inferences regarding the general
behaviour of the industry during the period April 1971
to March 1981.

5.1. Selection of Attributes

The ISM developed in Chapter IV has been
advantageously used to interact with the people in the
"field". The top officials, i.e., those involved in
decision making, were approached to provide information
regarding the attributes reflecting the performance of a
textile mill. These officials represented mainly the
Reserve Bank of India, the Industrial Development Bank,
the Indian Cotton Manufacturers Federation, the Stock
Exchange Foundation, and the Textile Commissioner's office,
Bombay. Two to three persons from each agency were
interviewed. The emphasis was mainly on identifying a
set of quantifiable indicators (or attributes) which could

have bearing on the performance of composite and
spinning mills. Quite a few of these attributes were
found to be the same as recommended by some of the
investigators whose studies have been reviewed in
Chapter III. The studies of Padmanabhan (1974), Eilon
(1976), SITRA (1979), Pranjape (1980), Bhatacharya et.al.
(1981) and Gupta (1983) need special mention. In all,
a set of 14 attributes were identified keeping in view
their practical utility and acceptability. These are
listed in Table 5.1. Each attribute is identified through
a symbol X_i ; i = 1, 2, ..., 14. It is observed that
these attributes are a mixture of financial, economic
and operational aspects and when considered on yearly
basis reflect short-term performance characteristics of
a mill. The first four attributes, namely, rate of return
before interest and depreciation (X_1), net worth as
percent of total liability (X_2), current asset to current
liability ratio (X_3), and net worth as percent of total
asset (X_4) are typical financial ratios commonly used in
financial literature (Altman, 1968; Lev, 1974; Gupta, 1983).
Total assets per equivalent spindle (X_5) and fixed assets
per equivalent spindler (X_6), determine how much financial
backing is available to the mill in terms of per unit
machine (equivalent spindle). The concept of equivalent
spindle, as recommended by Padmanabhan (1974) and

TABLE 5.1 :   List of the 14 Attributes giving Short-term
              Performance of Textile Mills

Sl.No.	Assigned variable Name	Title of the Attributes
1	X_1	Percent rate of return on total capital before interest and depreciation.
2	X_2	Percent net worth to total liability.
3	X_3	Current assets to current liability ratio.
4	X_4	Net worth as percent of total assets.
5	X_5	Total assets per equivalent spindle (in Rs.)
6	X_6	Fixed assets per equivalent spindle (in Rs.)
7	X_7	Stocks consumed as percent of sales.
8	X_8	Wages paid as percent of sales.
9	X_9	Sales per equivalent spindle (in Rs.)
10	X_{10}	Gross profits to net sales ratio.
11	X_{11}	Net sales to total assets ratio.
12	X_{12}	Percent spindle utilization.
13	X_{13}	Equivalent spindles per worker.
14	X_{14}	Number of operative days in a year.

Doraiswamy and Ratnam (1979), has been advantageously utilized to reduce the size effect of each mill. Stocks consumed as percent of net sale (X_7) and wages paid as percent of net sales (X_8) are two economic indicators and have been selected to evaluate the comparative economic structure of the mills. Sales per equivalent spindle (X_9), gross profit to net sales ratio (X_{10}), and net sales to total assets ratio (X_{11}) have been considered as the attributes showing sales turnover. The last three attributes, listed as X_{12}, X_{13} and X_{14}, are mainly gross statistics on physical performance of the mill.

5.2. Research Site and Sample

A sample of 75 mills was randomly selected from the four zones identified in Chapter II. The sample roughly corresponds to 11.3% of the total mills in the industry. However, if the NTC and STC mills are excluded, the sample represents about 14.15% of the total mills in the organized sector of the cotton textile industry. Statistically, such a sample is a large sample and can be considered to be a true representative of the actual population.

Table 5.2 gives the composition of the sample considering different zones. As such, the sample consists of 42 composite mills and 33 spinning mills. In terms of

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TABLE 5.2 : Selected Zonewise Sample

Zone	Composite Mills in the sample	Spinning Mills in the sample	Total Sample
Zone 1 (Ahmedabad)	12	3	15
Zone 2 (Bombay)	13	5	18
Zone 3 (South India)	7	18	25
Zone 4 (Rest of North)	10	7	17
Total Mills in the Sample	42	33	75
Percentage of Total Mills in the Country.	-	-	11.54

percentages, there are 56% composite mills and 44% spinning mills in the sample. In Appendix A, all the mills selected for the sample are listed. Each mill is assigned a 4-digit code for identification.

5.3. Behavioural Pattern of Selected Attributes

Relevant data pertaining to the various attributes have been collected for the sampled mills for a period of 10 years (April 1971 - March 1980) from the following sources:

(1)   Stock Exchange Official Directory, Sept. 1982.

(2)   Indian Cotton Manufacturer's Association, Bombay-Annual Survey, 1982.

The yearly data on each attribute for all the mills in the sample have been analyzed to obtain various descriptive statistics.

The descriptive statistics considered for each attribute were maximum, upper quartile, mean, median, lower quartile and minimum values. These are given in Table 5.3. Considering each attribute, the behavioural pattern of the mills in the sample has been studied by portraying the information graphically in the form of a time series.

TABLE 5.3 : Results of Descriptive Statistics of 14
Attributes.

Variable	Year	Maximum	Upper quartile	Mean	Median	Lower Quartile	Minimum
X_1	1971-72	52.82	11.0	7.71	8.09	4.0	-9.37
	72-73	30.89	14.0	10.80	10.49	8.0	-10.54
	73-74	47.19	18.0	14.17	13.20	10.0	-25.29
	74-75	32.53	20.0	16.54	14.30	12.0	- 4.75
	75-76	24.76	13.0	3.55	7.10	5.0	-33.76
	76-77	35.95	11.0	0.88	5.12	- 3.0	-42.5
	77-78	37.17	14.0	5.64	10.22	2.0	-66.8
	78-79	46.82	22.0	17.13	15.23	11.0	-36.12
	79-80	61.75	27.0	22.45	19.50	15.0	-23.86
	80-81	40.65	22.0	16.15	17.51	13.0	-57.41
X_2	1971-72	156.2	89.0	61.17	56.0	36.0	4.5
	72-73	294.0	71.0	59.28	48.62	33.0	9.9
	73-74	294.0	67.0	55.67	47.88	32.0	0.25
	74-75	333.0	61.0	55.68	48.07	37.0	17.85
	75-76	500.0	62.0	54.85	44.41	30.0	0.10
	76-77	400.0	51.0	45.96	32.89	20.0	0.19
	77-78	263.0	45.0	43.01	30.25	15.0	0.20
	78-79	250.0	52.0	43.28	36.67	23.0	1.0
	79-80	175.0	53.0	44.48	42.19	29.0	0.20
	80-81	166.6	57.0	46.74	45.88	28.0	0.20

TABLE 5.3 (contd..)

Variable	Year	Maximum	Upper Quartile	Mean	Median	Lower Quartile	Minimum
X_3	1971-72	1.67	1.15	1.128	1.15	1.0	0.54
	72-73	2.12	1.12	1.176	1.12	1.0	0.30
	73-74	2.47	1.148	1.125	1.14	1.0	0.30
	74-75	2.55	1.2	1.28	1.18	1.0	0.54
	75-76	3.54	1.2	1.57	1.13	1.0	0.56
	76-77	3.44	1.0	1.062	1.00	1.0	0.52
	77-78	2.87	1.0	1.034	1.00	1.0	0.48
	78-79	3.3	1.1	1.07	1.06	1.0	0.18
	79-80	4.01	1.2	1.161	1.10	1.0	0.56
	80-81	2.82	1.1	1.21	1.15	1.0	0.30
X_4	1971-72	61.0	43.0	35.45	35.75	27.00	4.0
	72-73	75.0	42.0	33.56	33.00	24.00	-10.0
	73-74	75.0	39.0	33.23	32.50	24.00	2.0
	74-75	77.0	37.0	33.60	32.60	27.00	15.0
	75-76	84.0	38.0	31.34	30.75	24.00	- 4.0
	76-77	80.0	32.0	24.72	24.75	13.00	-58.0
	77-78	72.0	31.0	20.04	21.25	8.00	-58.0
	78-79	72.0	32.0	19.98	23.33	9.00	-89.0
	79-80	68.0	34.0	24.98	27.00	18.00	-43.0
	80-81	62.0	36.0	24.98	30.25	20.00	-78.0

TABLE 5.3 (continued)

Variable	Year	Maximum	Upper Quartile	Mean	Median	Lower Quartile	Minimum
x_5	1971-72	995.0	537.0	435.0	362.0	271.0	120.0
	72-73	2387	549.0	481.0	404.0	311.0	155.0
	73-74	2540	648.0	547.7	466.5	340.0	186.0
	74-75	2575	729.0	662.9	564.0	444.0	246.0
	75-76	2449	740.0	660.9	523.5	432.0	225.0
	76-77	2877	742.0	673.5	526.0	433.0	203.0
	77-78	2790	829.0	696.3	544.0	425.0	231.0
	78-79	3423	864.0	780.8	592.0	462.0	240.0
	79-80	5553	974.0	900.7	683.0	528.0	264.0
	80-81	6235	1103.0	1032.2	775.5	601.0	314.0
x_6	1971-72	83.0	51.0	40.9	37.2	26.0	14.0
	72-73	92.0	45.0	36.9	34.0	25.0	13.0
	73-74	93.0	41.0	35.05	33.0	24.0	12.0
	74-75	76.0	38.0	32.25	29.6	24.0	9.0
	75-76	73.0	44.0	35.94	32.5	25.0	12.0
	76-77	69.0	44.0	35.74	33.75	26.0	10.0
	77-78	71.0	38.0	33.52	32.12	25.0	10.0
	78-79	68.0	38.0	31.72	29.75	24.0	10.0
	79-80	64.0	40.0	31.72	30.25	23.0	10.0
	80-81	66.0	40.0	34.08	33.83	26.0	20.0

TABLE 5.3 (continued)

Variable	Year	Maximum	Upper Quartile	Mean	Median	Lower Quartile	Minimum
X_7	1971-72	82.0	70.0	58.2	59.0	47.0	- 5.0
	72-73	78.0	64.0	55.6	55.1	45.0	34.0
	73-74	68.0	56.0	48.0	47.5	39.0	26.0
	74-75	68.0	58.0	48.2	46.0	37.0	20.0
	75-76	80.0	61.0	51.1	50.5	49.0	26.0
	76-77	78.0	64.0	53.4	54.0	42.0	- 1.0
	77-78	81.0	66.0	56.7	58.0	45.0	30.0
	78-79	75.0	64.0	51.7	52.2	41.0	- 1.0
	79-80	73.0	55.0	46.8	47.0	38.0	- 3.0
	80-81	69.0	52.0	45.8	45.8	38.0	28.0
X_8	1971-72	30.0	23.0	17.0	16.5	11.0	7.0
	72-73	35.0	23.0	18.5	19.0	12.0	6.0
	73-74	42.0	26.0	21.5	21.8	14.0	7.0
	74-75	37.0	25.0	20.13	19.7	14.0	2.0
	75-76	46.0	26.0	21.48	21.1	17.0	7.0
	76-77	40.0	23.0	19.8	19.3	14.0	6.0
	77-78	36.0	21.0	16.9	16.4	12.0	4.0
	78-79	38.0	20.0	17.2	16.2	12.0	4.0
	79-80	34.0	21.0	17.6	16.3	13.0	4.0
	80-81	47.0	23.0	18.8	18.0	14.0	6.0

TABLE 5.3 (Continued)

Variable	Year	Maximum	Upper Quartile	Mean	Median	Lower Quartile	Minimum
X_9	1971-72	1990	617	623	559	485	4
	72-73	2132	800	713	625	512	110
	73-74	2364	869	770	651	569	376
	74-75	4877	1033	988	805	693	307
	75-76	4846	1187	1028	822	658	448
	76-77	6732	1088	1094	890	703	343
	77-78	6668	1407	1294	1086	860	588
	78-79	6914	1600	1431	1209	964	609
	79-80	8051	1631	1558	1266	1070	638
	80-81	9664	1833	1715	1332	1144	722
X_{10}	1971-72	31.0	9.0	7.2	6.9	3.0	-11.0
	72-73	28.0	12.0	9.2	8.0	7.0	- 6.0
	73-74	36.0	17.0	12.7	11.9	8.0	- 2.0
	74-75	40.0	17.0	13.1	12.0	7.0	- 5.9
	75-76	28.0	9.0	5.6	5.2	2.0	-13.2
	76-77	21.0	8.0	3.8	3.5	-2.0	-15.0
	77-78	17.0	9.0	5.2	6.5	3.0	-41.2
	78-79	25.0	12.0	8.8	9.5	6.0	-37.0
	79-80	33.0	15.0	12.3	11.9	8.0	- 5.7
	80-81	33.0	14.0	10.5	10.0	7.0	-15.0

TABLE 5.3 (continued)

Variable	Year	Maximum	Upper Quartile	Mean	Median	Lower Quartile	Minimum
X_{11}	1971-72	3.4	2.0	1.55	1.62	1.0	0.60
	72-73	3.1	2.0	1.63	1.69	1.0	0.38
	73-74	2.8	2.0	1.52	1.49	1.0	0.36
	74-75	3.2	2.0	1.57	1.47	1.0	0.30
	75-76	2.6	2.0	1.61	1.60	1.0	0.70
	76-77	3.1	2.0	1.73	1.79	1.0	0.51
	77-78	3.6	2.0	1.99	1.95	1.0	0.99
	78-79	3.2	2.0	1.98	1.93	1.0	0.94
	79-80	3.2	2.0	1.9	1.70	1.0	0.97
	80-81	3.0	2.0	1.8	1.74	1.0	0.96
X_{12}	1971-72	92	89	83.6	84.6	78	18
	72-73	97	92	84.0	85.0	80	57
	73-74	97	89	80.6	81.9	74	48
	74-75	97	88	79.4	80.0	72	49
	75-76	95	86	77.4	78.5	68	42
	76-77	96	88	78.4	80.6	73	23
	77-78	96	88	78.7	80.0	72	46
	78-79	98	90	81.0	80.8	75	52
	79-80	98	89	81.0	81.3	75	52
	80-81	99	90	80.0	80.0	71	50

TABLE 5.3 (continued)

Variable	Year	Maximum	Upper Quartile	Mean	Median	Lower Quartile	Minimum
X_{13}	1971-72	82	40	36	33	27	18
	72-73	96	41	36	33	29	16
	73-74	89	39	35	32	27	17
	74-75	82	39	34	32	27	15
	75-76	74	39	34	31	29	19
	76-77	78	43	36	34	28	17
	77-78	151	43	37	34	27	18
	78-79	151	44	38	34	26	17
	79-80	112	44	38	33	28	16
	80-81	89	40	36	33	27	16
X_{14}	1971-72	360	332	316	307	305	272
	72-73	363	325	315	310	304	223
	73-74	363	312	303	302	294	202
	74-75	360	324	316	307	300	205
	75-76	360	345	314	306	298	205
	76-77	361	351	323	311	307	204
	77-78	360	351	325	318	309	201
	78-79	360	349	324	312	304	201
	79-80	361	335	314	303	300	210
	80-81	361	345	318	309	301	210

The data on attributes have been analysed using
SPSS (Nie et. al., 1975) on DEC - 1090 computer available
at the Indian Institute of Technology, Kanpur. In the
following sections the details of the time series plots
for the 14 attributes are presented.

5.3.1. Time Series Plots

The time series behaviour of the 14 attributes for
the sampled mills is portrayed in Figures 5.1 through 5.14.
Figure 5.1 presents the rate of return before interest
and depreciation. It is observed that there has been
poor performance by the industry during the years 1975
to 1977. The years 1975 and 1976 have been reported to be
the cotton crop failure years and probably the effect of
the crop failure during these years also influenced the
performance of the industry in the following year. During
these years, the mills belonging to the lower quartile
based on this attribute faced serious monitory loss and
they were not in a position to earn adequate rate of return.
Further, for the year 1976-77 the median and upper
quartile values for the attribute were 5.12 and 11.0,
respectively. This implies that about 75% of the sampled
mills could earn not more than 11% of rate of return on
investment before interest and depreciation, for the year.
During the period under investigation, the mean value of the
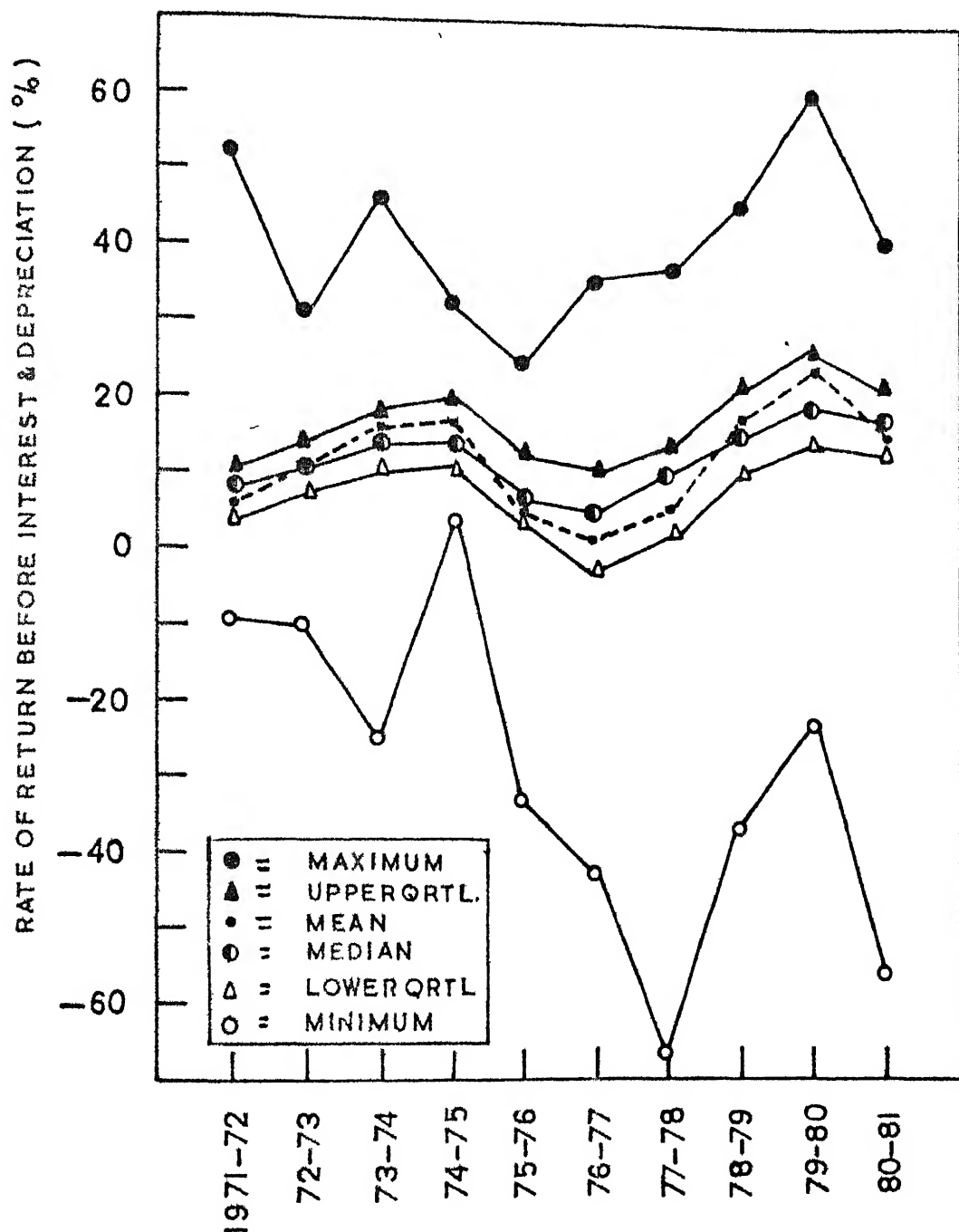
FIGURE 5·1. RATE OF RETURN BEFORE INTEREST
AND DEPRECIATION (X_1).

rate of return touched an all time low value of 0.88% in 1976-77 and was never higher than 16.54% (in 1974-75). This clearly brings out the crises which the industry has faced in the past.

Figure 5.2 shows the time series plot of net worth to total liability ratio. The plot shows that over the years there has been deterioration in the performance of the industry with respect to this attribute. It is observed that the highest value the upper quartile could attain was in 1971-72 (89%) and it fell to all time low in 1977-78 (45%).

Figure 5.3 shows the time series plot of current assets to current liability ratio. This figure suggests that in large number of cases the value of this attribute is close to 1.

Figure 5.4 suggests that the networth to total assets ratio sharply declined during the years 1976-77 and 1977-78 for mills belonging to the lower quartile. The mean value of this attribute has gone down from 35.45% (in 1971-72) to 24.98% (in 1980-81) indicating the steady deterioration in the performance of the industry with respect to this attribute.

Figure 5.5 shows that the mean value of total assets per equivalent spindle has increased steadily over the years.
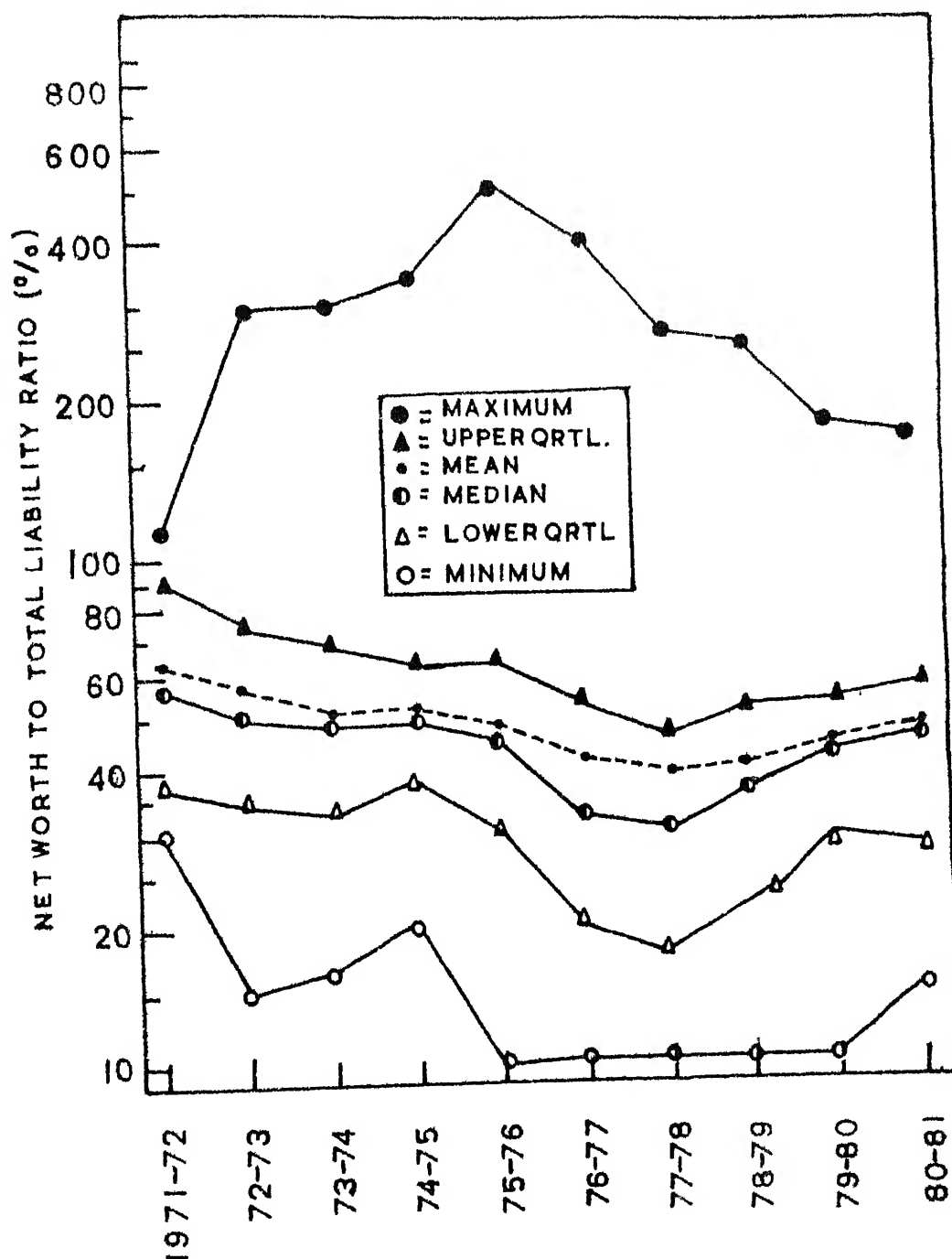
FIGURE 5·2. NET WORTH TO TOTAL LIABILITY RATIO (X₂).
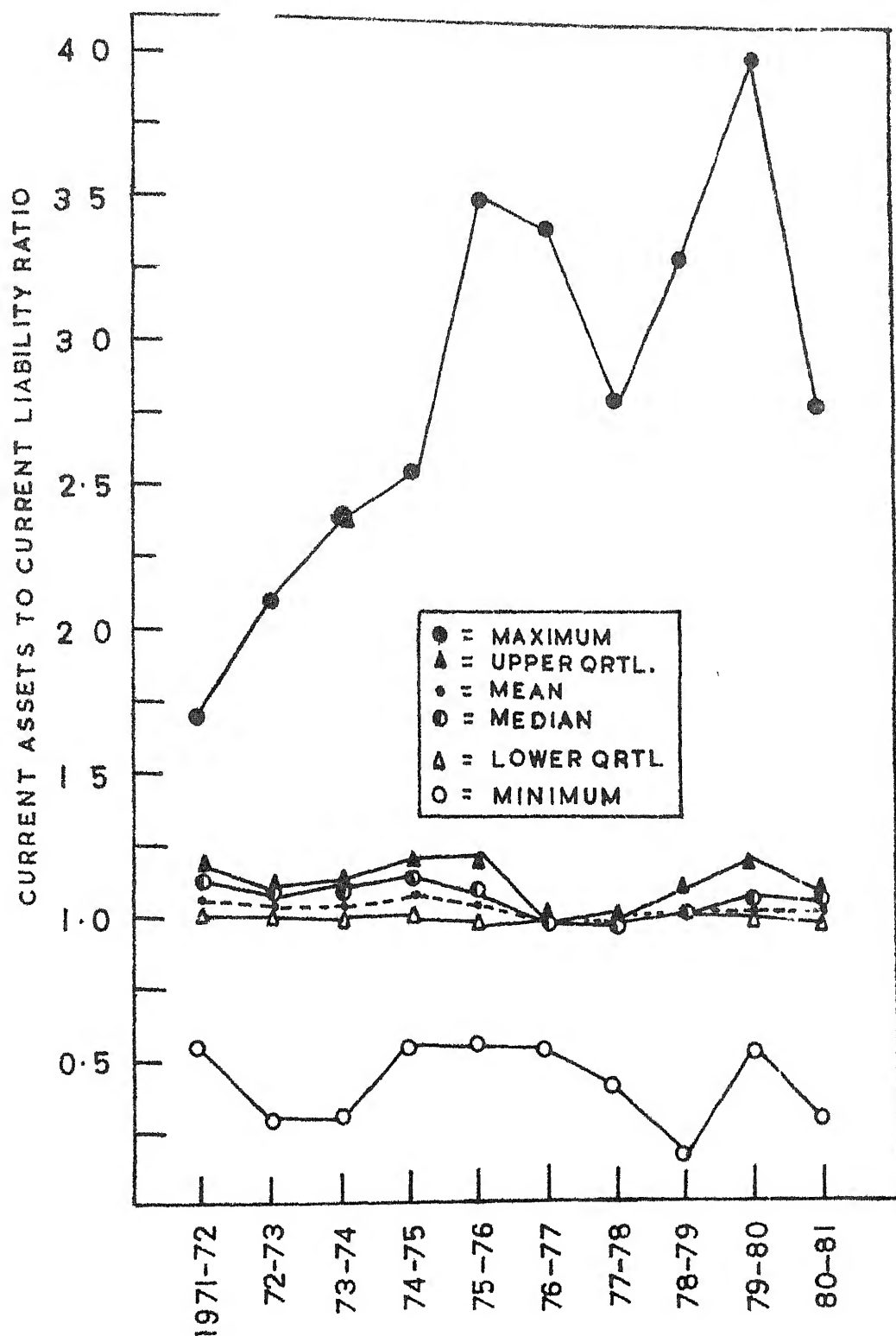
FIGURE 5·3. CURRENT ASSETS TO CURRENT LIABILITY RATIO (X_3).
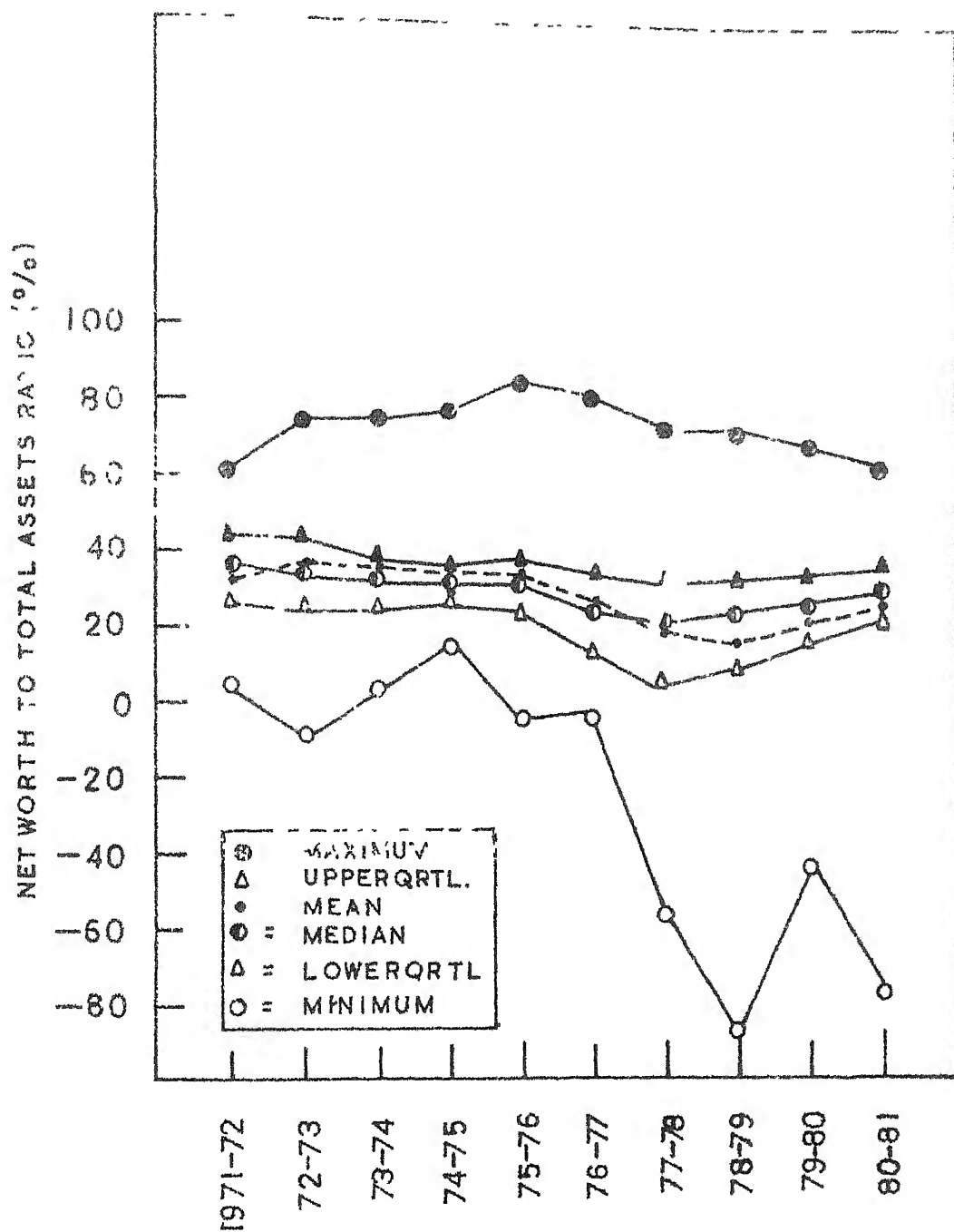
FIGURE 5·4. NET WORTH TO TOTAL ASSETS RATIO(X_4).
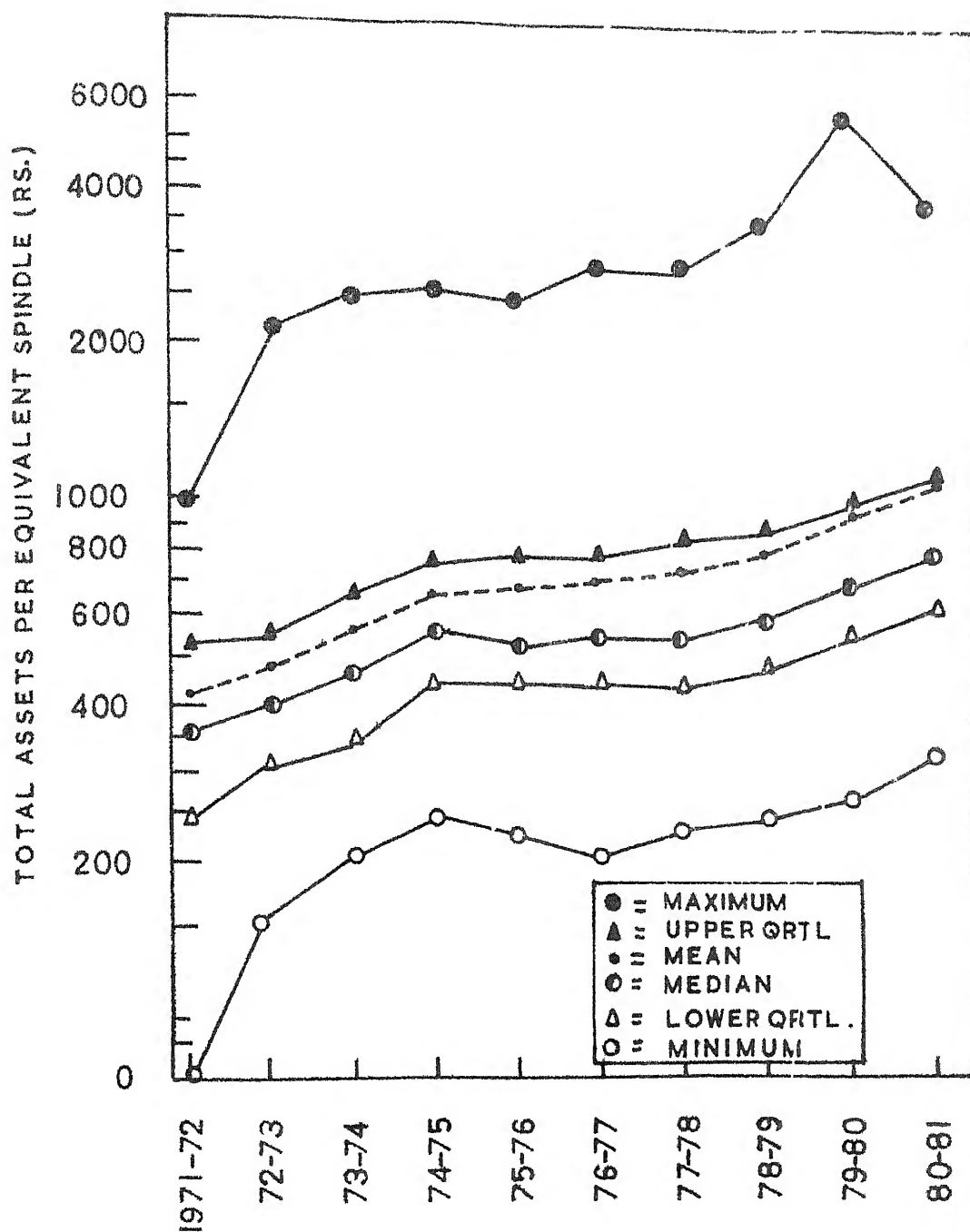
FIGURE 5·5. TOTAL ASSETS PER EQUIVALENT
SPINDLE (X₅).

However, no such trend is observed in the plot for fixed asset per equivalent spindle portrayed in Figure 5.6. This confirms the findings of NPC (1978) regarding the suspected cash diversion by the mills to areas other than machines, equipment replacements and other similar fixed assets.

Figure 5.7 gives a plot for the attribute: stock consumed to sales ratio (percent). Considering the mean value of the attribute, it is observed that there was improvement in the performance of the industry during the years 1972-73 and 1974-75 as compared to the year 1971-72. However, the mean value of the stock consumed to sales ratio steadily increased from 1975-76 to 1977-78 indicating deterioration in the general performance by the industry. The poor performance during this period could be attributed to the non-availability of cotton which resulted from the cotton crop failure. Subsequently, i.e., during the period 1978-79 to 1980-81, there has been steady improvement due to abundance in the availability of cotton fibre.

Figures 5.8 and 5.9 depict wages paid as percentage of the sales and sales per equivalent spindle, respectively. The plots of these figures suggest that even though sales per equivalent spindle has generally risen steadily over
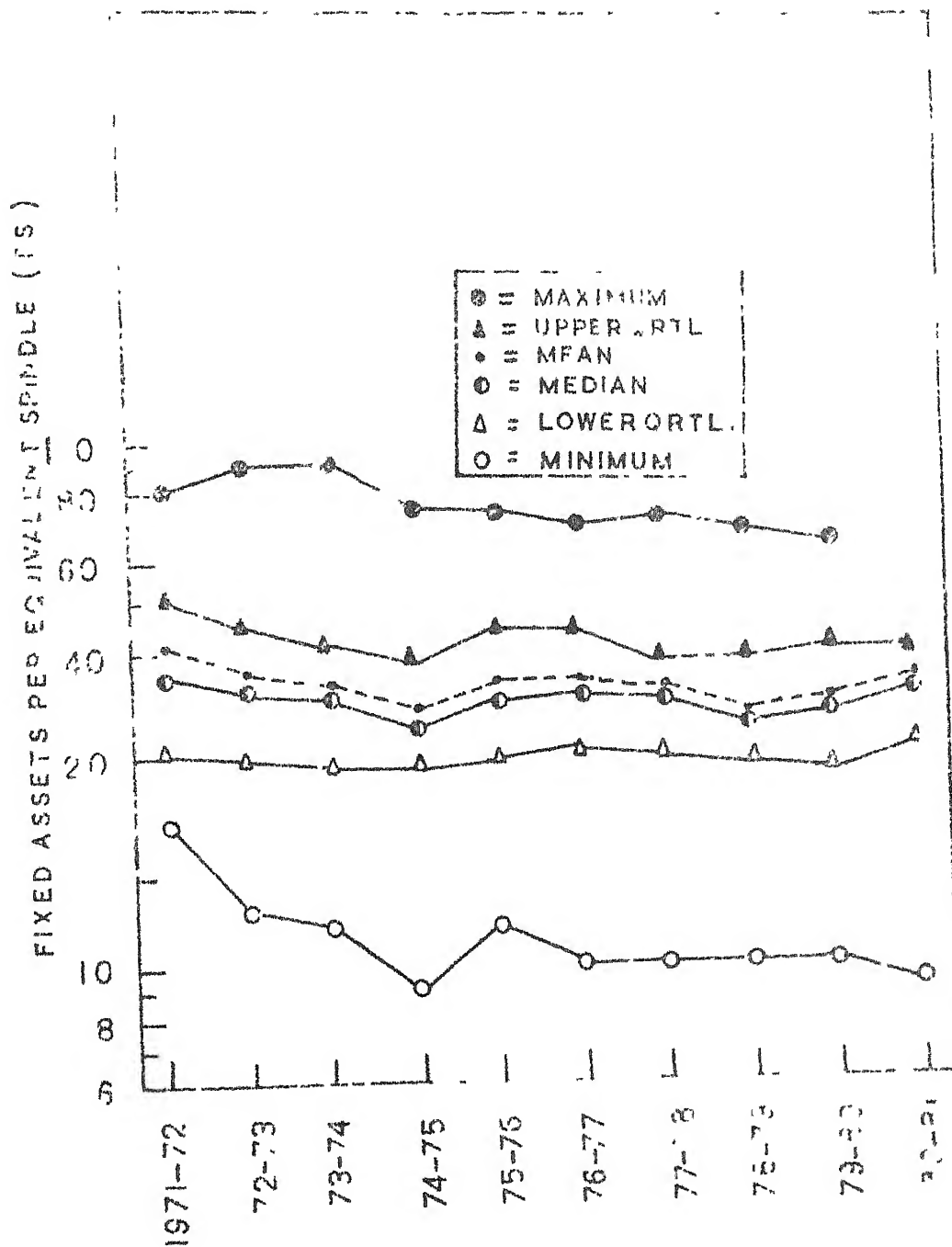
FIGURE 5 6. FIXED ASSETS PER EQUIVALENT SPINDLE (X6).
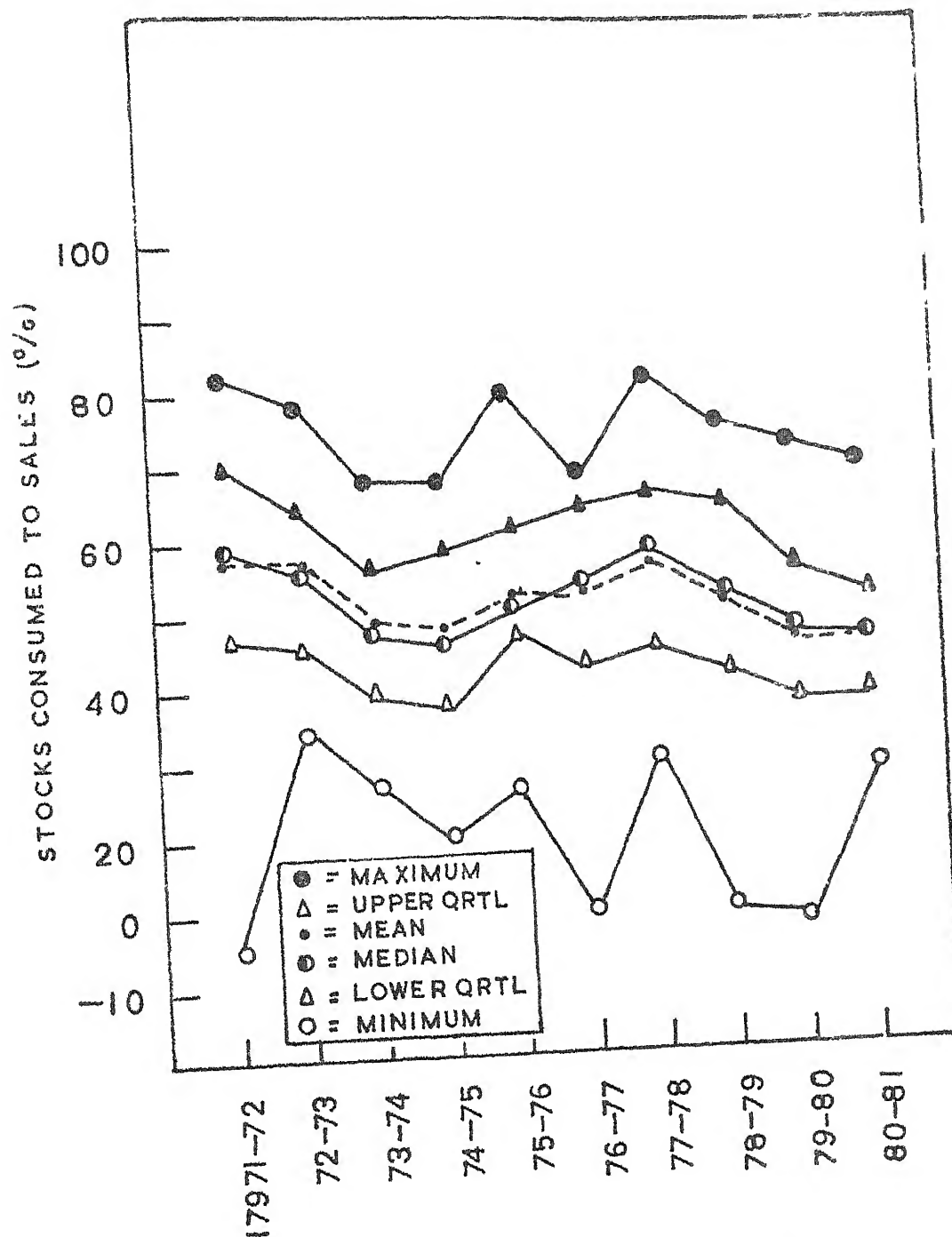
FIGURE 5·7. STOCKS CONSUMED TO SALES RATIO (X₇).
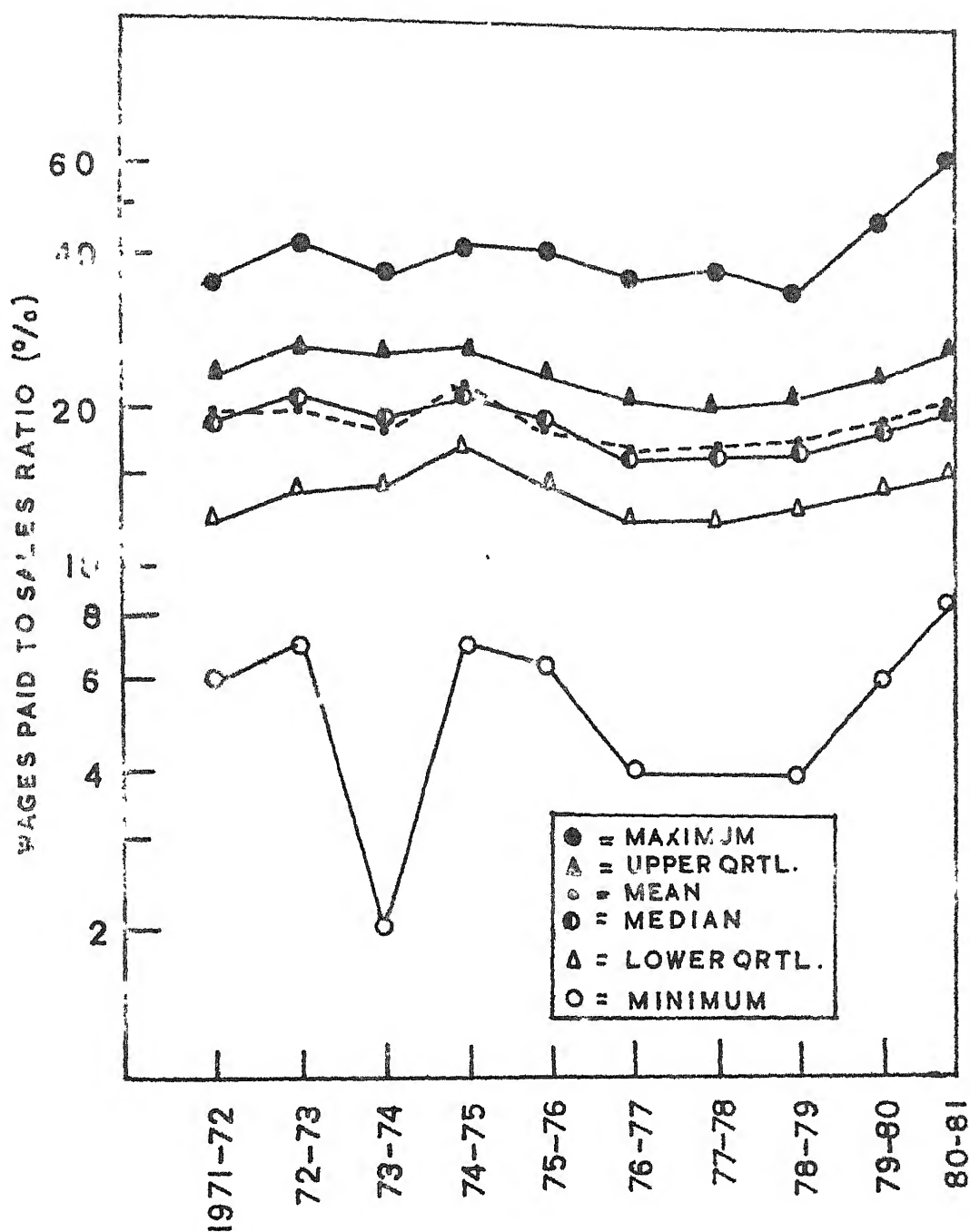
FIGURE 5·8. WAGES PAID AS PERCENTAGE OF SALES (X_8).
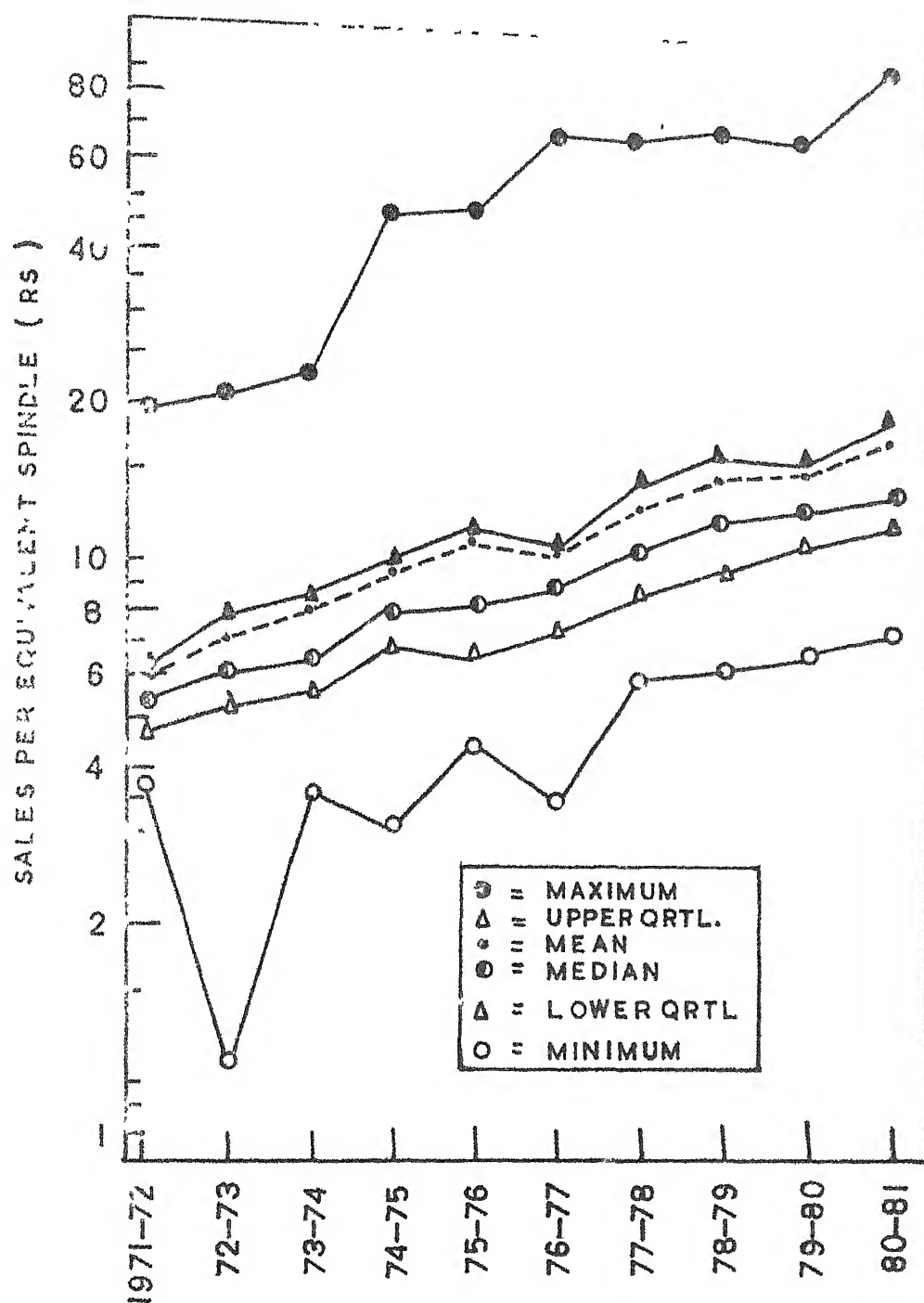
FIGURE 5·9. SALES PER EQUIVALENT SPINDLE (X_9).

the years, wages paid have not been commensurate with the sales volume. This observation is specifically valid for the years 1976-77 to 1978-79.

The behaviour of the industry for the attribute gross profit to net sales (Figure 5.10) over the period 1971-72 to 1980-81 has been identical to the attribute rate of return before interest and depreciation (Figure 5.1). The plots given in Figure 5.10 further corroborate the finding that there has been worsening trend in the performance of the industry.

Figure 5.11 shows the plots for the net sales to total assets ratio. It is observed that the mean value of this attribute has marginally increased over the years. The percentage spindle utilization which is shown in Figure 5.12 dipped from a mean value of 84% in 1972-73 to 77.4% in the year 1975-76. Since 1975-76 was a poor cotton crop year, this decrease in spindle utilization could partly be attributed to this factor. The decreased spindle utilization could also partially arise from the wearing out of plant and machinery over the years. This is apparent from the fact that the spindle utilization was only 81% in 1979-80 as compared to 84% in 1972-73.

Figure 5.13 shows equivalent spindle per worker employed in the sampled mills. The mean value of this
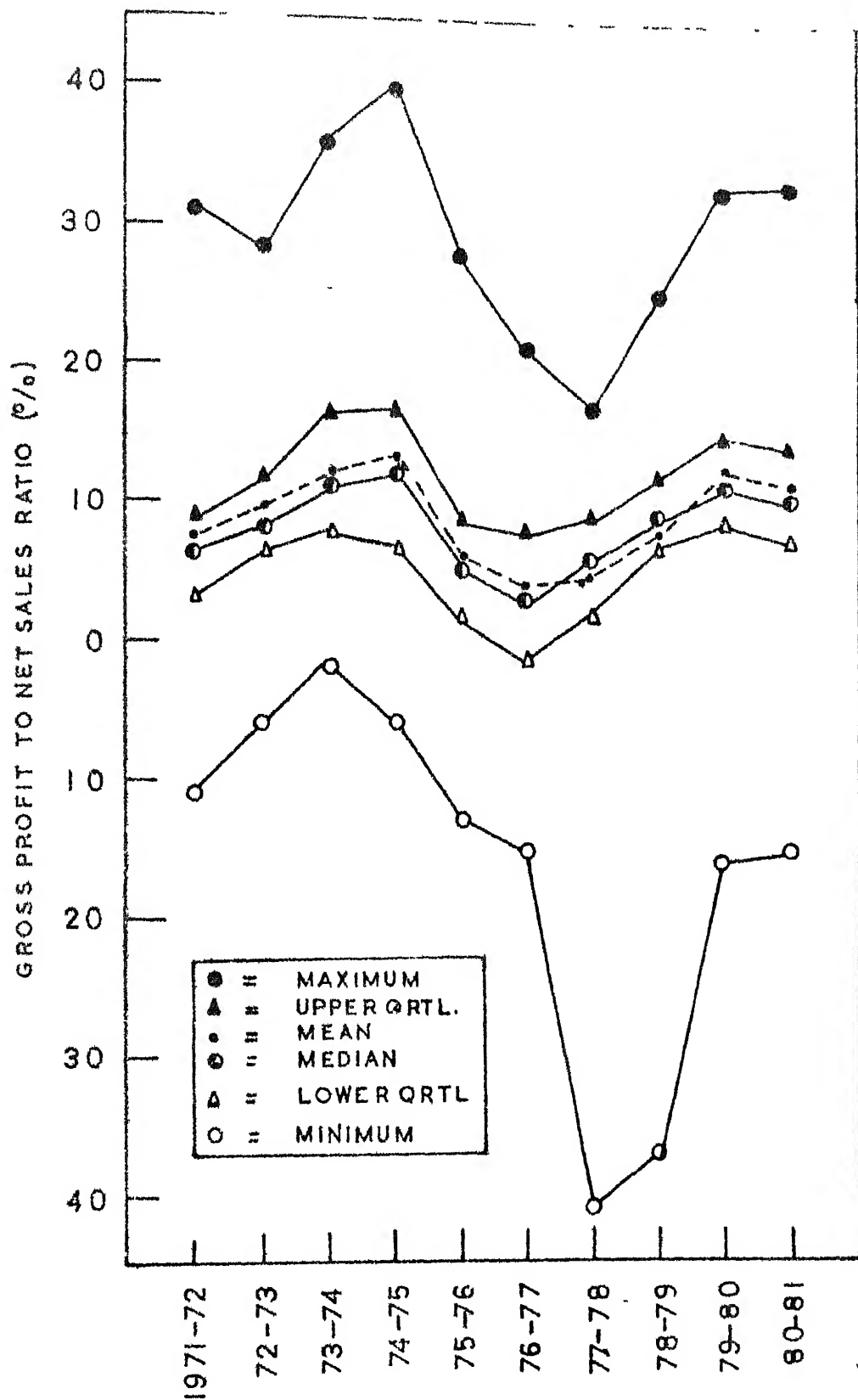
FIGURE 5·10. GROSS PROFIT TO NET SALES RATIO (X₁₀).
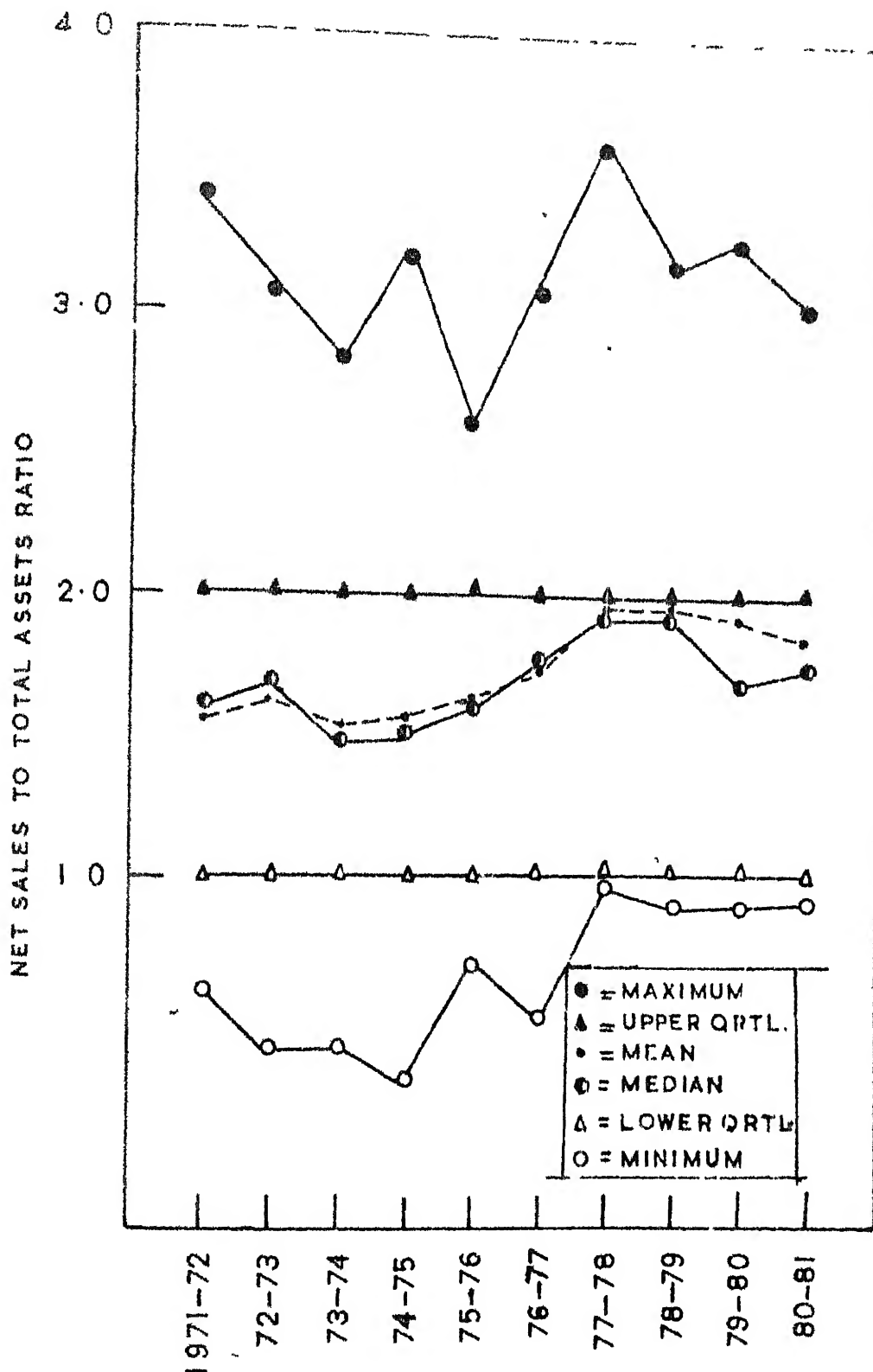
FIGURE 5·11. NET SALES TO TOTAL ASSETS RATIO(X_{11}).
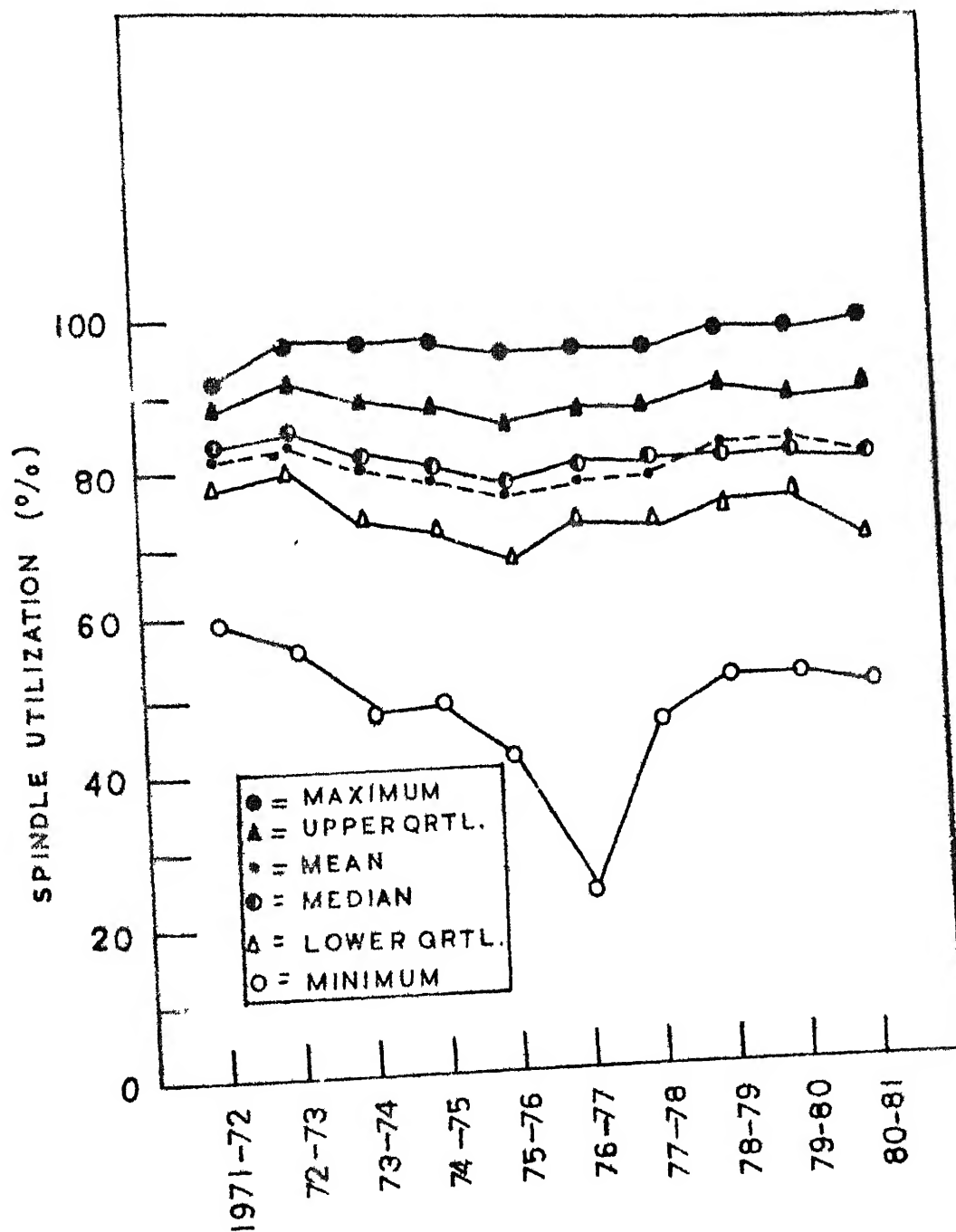
FIGURE 5·12.SPINDLE UTILIZATION IN PERCENT (X₁₂).
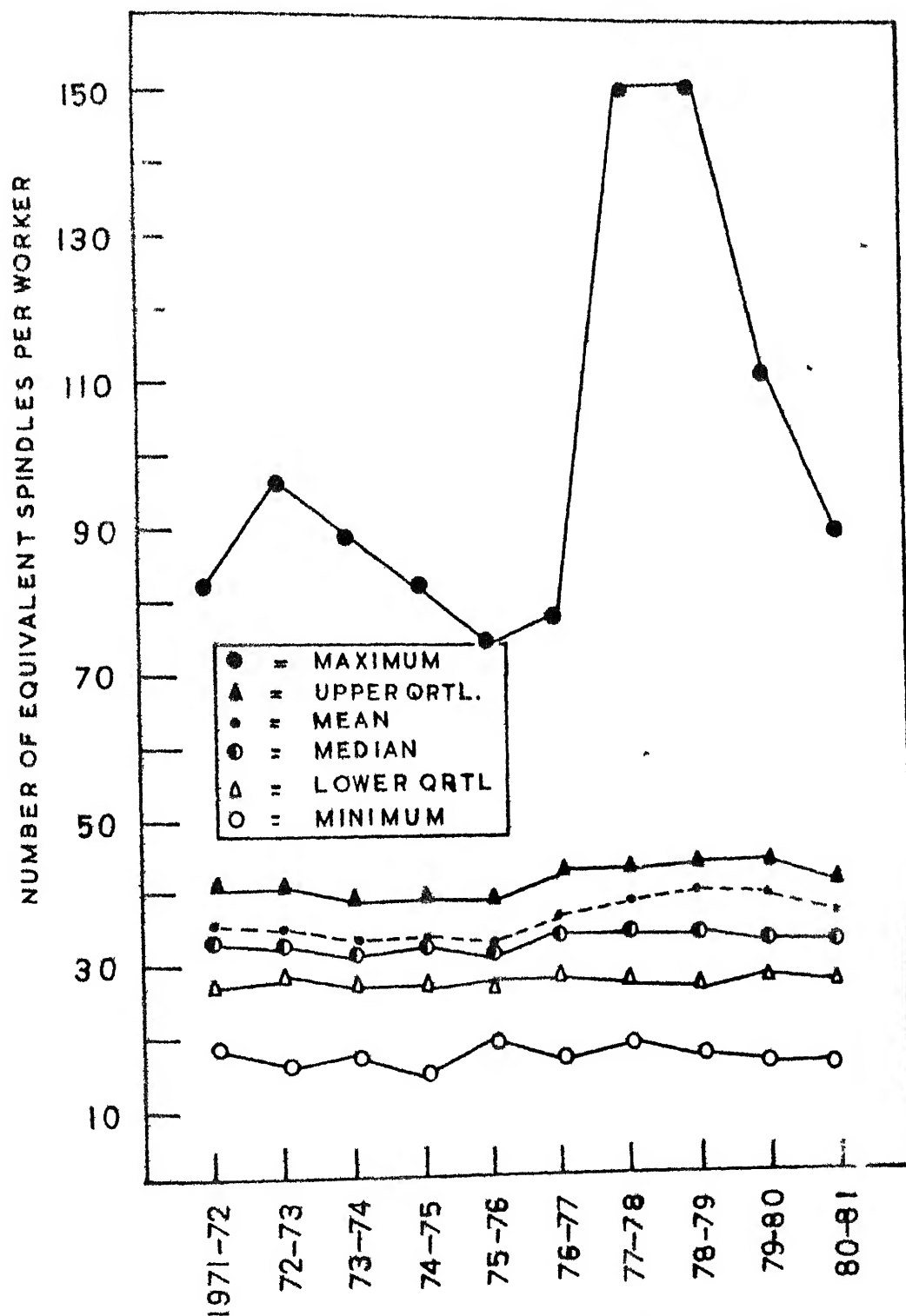
FIGURE 5·13. NUMBER OF EQUIVALENT SPINDLES ASSIGNED PER WORKER (X_{13}).
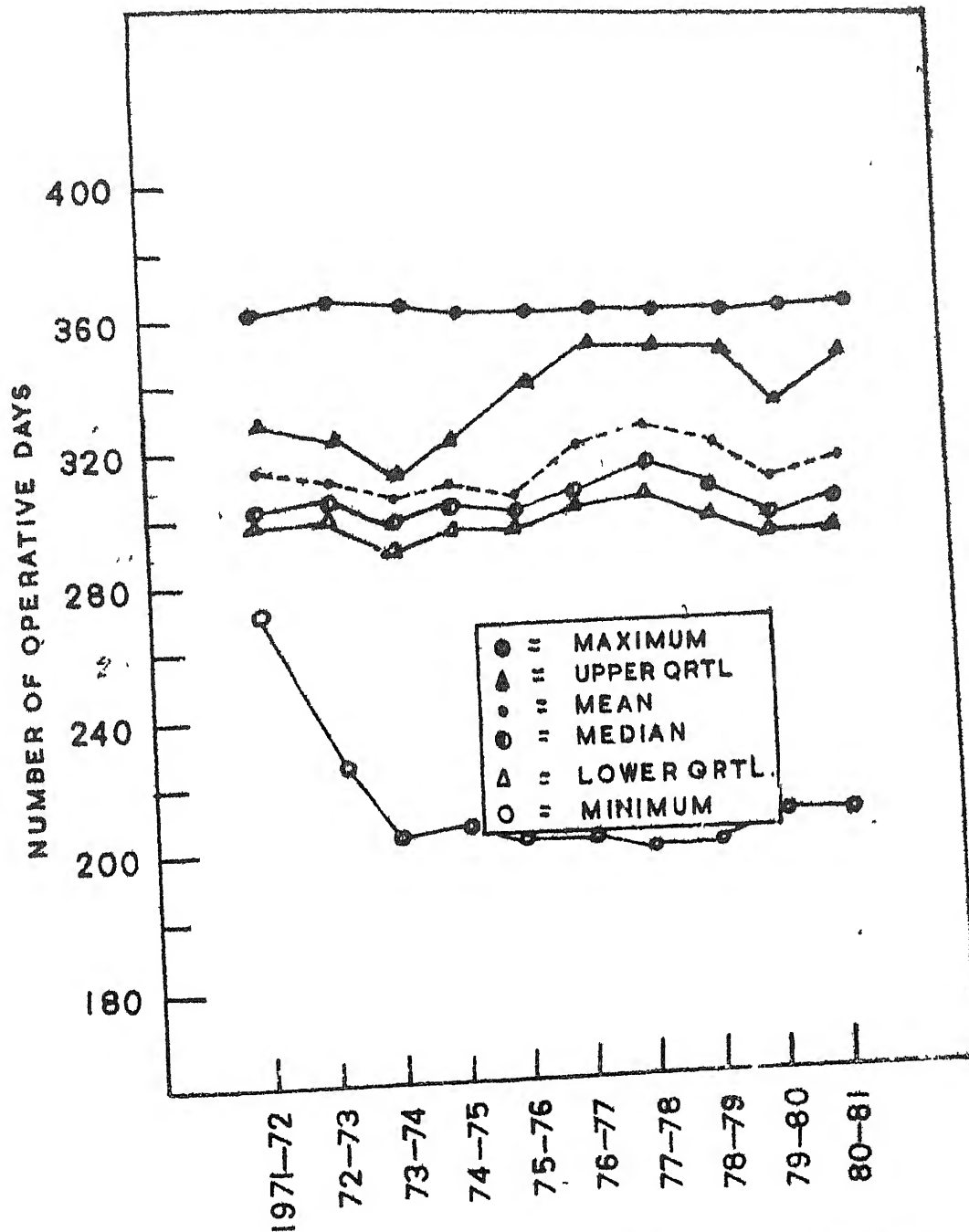
FIGURE 5·14. NUMBER OF OPERATIVE DAYS IN THE YEAR (X14).

attribute has been quite steady over the years.

The number of operative days during the year for the sampled mills is displayed in Figure 5.14. It is observed that the difference between the mills falling in the upper quartile and lower quartile groups widened during the crisis years of 1975-76 to 1977-78. This is indicated by the sudden increase in quartile deviation value to 47 (in 1975-76), 44 (in 1976-77) and 42 (in 1977-78) as against 24 in the year 1974-75.

5.4. Conclusion

Time series plots presented in this chapter display the historical perspective of the sample mills with respect to the 14 attributes. Specifically, the plots concerning the following attributes confirm the crisis the cotton textile mills have faced during the period April 1971 to March 1981.

(1)   Rate of return before interest and depreciation (Figure 5.1).

(2)   Net worth to total assets (Figure 5.4).

(3)   Fixed asset per equivalent spindle (Figure 5.6).

(4)   Wages paid as percentage of sales (Figure 5.8).

(5)   Gross profit to net sales ratio (Figure 5.10).

(6)   Spindle utilization (Figure 5.12).

The plots on Figures 5.3 and 5.4 confirmed the suspected diversion of capital into assets other than fixed assets. Further the performance of the textile mills has been very susceptible to fluctuations in the production of cotton fibre.

CHAPTER VI

MODELLING FOR THE ASSESSMENT OF HEALTH STATUS
OF MILLS

In this chapter an attempt has been made to develop a unitary measure for determining the health status of a textile mill in comparative parlance. Various short-term and long-term mill performance indicators are considered for this purpose. The fourteen short-term performance attributes presented in Chapter IV are factor analyzed in order to identify surrogates representing the short-term performance. Next, the mills are considered as business systems and the concepts of risk, stability, and resilience are introduced to develop surrogates encompassing long-term performance aspects. Both the short-term and long-term surrogates have been utilized for developing a discriminant model which can be used to measure the health status of a mill.

6.1. Identification of Short-term Performance Surrogates

The 14 attributes presented in Chapter V reflect short term performance aspects of a textile mill. These attributes emancipate from an operating entity and represent financial, economic and operational characteristics of a mill. The basic question which needs to be answered is

the inherent variation in the data. In addition, the technique ensures orthogonality among the new variables, called principal components or factors. However, these explanatory variables are not observable. They are rather linear combination of the original variables. In general there are three major steps involved in factor analysis. These are: (1) the preparation of the correlation matrix for the variables, (2) the extraction of the initial factors - the exploration of possible data reduction, (3) the rotation to a terminal solution - the search for simple and interpretable factors.

In the literature, a variety of approaches have been suggested for factor analysis (Fruchter, 1954; Thurstone, 1965). However, in the present investigation, the method of Principal Factoring with Iteration followed by Varimax Rotation Method has been used. The method of Principal Factoring with Iteration is the most widely accepted factoring method and can handle most of the initial factoring needs of the user (Nie et.al., 1975). In this method, the first step is to prepare a correlation matrix for all the variables under consideration. Initial estimates of communalities (h^2) for a variable are obtained by summing the squares of the correlation coefficients of the variable with rest of the variables. The main diagonal

of the correlation matrix is replaced by the communality estimates and solved for eigen values and eigen vextors. The number of principal factors to be retained for the final rotated solution will ordinarily be determined by the specification of minimum eigen value criterion. Generally, the minimum eigen value for extracting the principal factors is taken to be 1. This ensures that each of the components extracted as the principal factor is significant and accounts for at least the total variance of a single variable. From the eigen vectors corresponding to the principal factors, revised communalities are calculated for each variable and the main diagonal of the original correlation matrix is replaced by the new set of communalities and solved for eigen values and eigen vectors. It may be mentioned that the eigen vector corresponding to a component or factor represents the loading of the factor on the various variables. Communality estimates for each variable are obtained by sum of the squares of factor loadings on the variable. The iterative process is continued until the differences between the two successive communality estimates are negligible. A matrix whose columns represent eigen vectors of the principal factors corresponding to the final (acceptable) iteration is called 'Initial Factor Matrix'.

The initial factor matrix, is next rotated by the varimax rotation technique with a view to simplify the factor structure. Varimax criterion centres on simplifying the columns of a factor matrix such that a variable loads high on one factor but almost zero on all others. The varimax rotated factor matrix is then used to obtain the factor score coefficients using the following relationship:

$$C = S^T R^{-1}$$

where C is the factor score coefficient matrix, S^T is the transpose of rotated factor matrix and R^{-1} represents the inverse of the original correlation matrix.

A factor score scale is then built for each factor in the final solution. For each data case a vector of factor scores $\underline{f}$ is calculated:

$$\underline{f} = CZ$$

where Z is the vector of standardized values of the variables which have been factor analyzed.

6.1.2. Factor Analysis of the Data

The data from 75 sampled mills concerning the 14 short term performance attributes for a period of 10 years has been factor analyzed. Using routine FACTOR of the SPSS package (Nie et.al., 1975) on DEC-1090 computer. The

routine FACTOR uses the method of Principal Factoring with
Iteration followed by Varimax Rotation Method. The control
statements used for running the SPSS package are listed
in Appendix B.

Table 6.1 gives the correlation matrix for the
attributes (variables) alongwith the mean and standard
deviation of each variable. Using the correlation matrix,
the initial values of the communality estimates are
obtained and further utilized to generate the principal
components. Table 6.2 shows the communality estimates of
the variables, associated principal components and their
eigen values. This table indicates that there are five
principal components with eigen values greater than 1 and
are selected as the factors. The communalities, h^2, of
the variables are improved in an iterative fashion. In all,
25 iterations were required. The final loadings of the
variables on the 5 principal factors are shown in Table 6.3.
The varimax rotated factor matrix and communalities
associated with each of the variables is given in Table 6.4.
For each variable, the factor carrying highest loading is
identified by underlining the corresponding factor loading.
The percentage variation explained by each factor is also
presented in this Table. We observe that the factors F_1,
F_2, F_3, F_4, F_5 explain 38.10%, 20%, 17.5%, 13.5% and 10.9%

TABLE 6.1: Correlation Matrix

Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X_1	1	.07	.17	.23	.07	-.06	-.19	-.18	.14	.60	.14	.07	.10	.03
X_2	.07	1	.60	.80	.29	.07	.14	-.27	.12	.26	-.24	-.25	.01	.10
X_3	.17	.60	1	.63	.27	-.16	-.03	-.18	.20	.32	-.13	.01	-.10	.08
X_4	.23	.80	.63	1	.21	.17	.15	-.39	.11	.47	-.23	.02	.11	.07
X_5	.07	.29	.27	.21	1	.13	.08	-.35	.06	.15	-.27	-.04	-.18	.28
X_6	-.06	.07	-.16	.17	.13	1	.42	-.42	.05	.14	-.31	-.16	.22	.13
X_7	-.19	.14	-.03	.15	.08	.42	1	-.54	.06	.06	.02	-.21	.03	.22
X_8	-.18	-.27	-.18	-.39	-.35	-.42	-.54	1	-.32	-.41	.07	.15	-.23	-.29
X_9	.14	.12	.20	.11	.86	.05	.06	-.32	1	.07	.09	.02	-.23	.32
X_{10}	.60	.26	.32	.47	.15	.14	-.06	-.41	.07	1	-.24	-.05	.31	-.001
X_{11}	.14	-.24	-.13	-.23	-.27	-.31	.02	.07	.09	-.24	1	.15	-.09	.28
X_{12}	.07	-.25	.01	.02	-.04	-.16	-.21	.15	.02	-.05	.15	1	.11	-.04
X_{13}	.10	.01	-.10	.11	-.18	.22	.03	-.23	-.23	.31	-.09	.11	1	-.21
X_{14}	.03	.10	.08	.07	.28	.13	.22	-.29	.32	-.001	.08	-.04	-.21	1
Mean	11.78	50.51	1.14	27.72	717.65	34.49	51.12	18.94	1162.46	8.92	1.73	80.49	36.48	316.64
S.D	13.73	42.58	0.39	18.17	585.10	13.43	13.10	7.04	846.13	7.70	0.51	10.91	15.06	29.51

TABLE 6.2 : Estimated Communalities of Variables and
Associated Principal Components

Variable	Estimated Communality	Principal component	Eigen value
X_1	0.49600	1	3.58653
X_2	0.82049	2	2.05565
X_3	0.57540	3	1.93842
X_4	0.82455	4	1.49565
X_5	0.90624	5	1.19380
X_6	0.43174	6	0.99601
X_7	0.50498	7	0.73992
X_8	0.62934	8	0.56075
X_9	0.89518	9	0.46182
X_{10}	0.65115	10	0.31708
X_{11}	0.66003	11	0.27428
X_{12}	0.16184	12	0.22411
X_{13}	0.33922	13	0.11236
X_{14}	0.21855	14	0.04362

TABLE 6.3: Initial Factor Matrix using Principal Factor
with iterations

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
X_1	0.29196	-0.23921	0.24480	0.56919	0.06349
X_2	0.74446	-0.28173	0.14602	-0.45424	0.17458
X_3	0.59542	-0.22228	0.37580	-0.23436	0.13385
X_4	0.78671	-0.38149	0.05701	-0.20034	0.17092
X_5	0.64099	0.62924	0.24792	0.00191	-0.32898
X_6	0.28959	0.09859	-0.60324	0.02216	-0.13913
X_7	0.27574	0.26491	-0.62130	-0.12718	0.33706
X_8	-0.65457	-0.16164	0.45219	-0.25439	-0.18725
X_9	0.49233	0.69956	0.33177	0.18306	-0.03253
X_{10}	0.58959	-0.43535	-0.00684	0.54510	-0.18574
X_{11}	-0.31663	0.17297	0.23553	0.30550	0.73302
X_{12}	-0.09307	-0.07319	0.21836	0.08085	0.05289
X_{13}	0.07208	-0.32686	-0.29963	0.23504	-0.07213
X_{14}	0.24946	0.34107	-0.03411	0.02343	0.16365

TABLE 6.4: Varimax Rotated Factor Matrix and Variable Communalities

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communality h^2
X_1	.108	.104	-.172	.668	.177	.530
X_2	.926	.080	.124	.006	-.105	.891
X_3	.745	.179	-.132	.109	-.009	.618
X_4	.849	.025	.185	.272	-.075	.837
X_5	.179	.924	.093	.043	-.285	.976
X_6	-.046	.014	.626	.112	-.263	.477
X_7	.078	.049	.781	-.137	.153	.662
X_8	.203	-.271	-.701	-.382	-.072	.758
X_9	.063	.926	.039	-.07	.086	.876
X_{10}	.265	.025	.057	.871	-.179	.868
X_{11}	-.163	.018	-.136	-.028	.877	.816
X_{12}	-.002	-.017	-.234	-.051	.115	.071
X_{13}	-.034	-.289	.188	.36	-.108	.262
X_{14}	.066	.350	.234	-.036	.153	.207
Eigen value	3.378	1.77	1.545	1.193	0.965	
Percent of variance explained	38.1	20.0	17.5	13.5	10.9	

of the total variation, respectively. The five extracted factors are capable of explaining 73.4% of the total variation, inherent in the data. A brief interpretation of each of the extracted factors based on Table 6.4 is presented below:

Factor 1 (F_1) :   It is the largest construct of the 5 factors accounting for 38.1% of the total variation. The variables X_2 (per cent net worth to current liability), X_3 (current asset to current liability ratio) and X_4 (net worth as per cent of total assets) carry their respective highest loadings on this factor. Further, the h^2 values associated with these variables are fairly high. Since, this factor carries very high loadings on variables representing financial solvency, it may be interpreted as 'financial factor'.

Factor 2 (F_2) :   It is the second largest construct accounting for 20% of the total variation. The variables X_5 (total assets per equivalent spindle), X_9 (sales per equivalent spindle), and X_{14} (number of operative days in a year) carry their respective highest loadings on this factor. However, X_{14} has a relatively low value for loading on this factor. Further, the h^2 value associated with this variable is only 0.207, which implies that the

variability associated with this variable can not be adequately explained by the extracted factors. In view of these observations, it is concluded that this factor is primarily influenced by the variables which indicate the strength of each mill in terms of its assets and sales per equivalent spindle, and may be interpreted as 'assets and turnover strength indicator'.

Factor 3 (F_3) : This factor accounts for 17.5% of the total variation. The variables X_6 (fixed assets per equivalent spindle), X_7 (stock consumed as per cent of sales), X_7 (wages paid as per cent of sales) and X_{12} (spindle utilization ratio). All these variables carry reasonably high values for h^2 except X_{12}. Further, the loading of the variable X_{12} on this factor is relatively low. Therefore, F_3 is primarily influenced by the variables X_6, X_7 and X_8 and may be interpreted as 'economic factor'.

Factor 4 (F_4) : This factor explains 13.5% of the total variation. The variables X_1 (rate of return before interest and depreciation), X_{10} (gross profit to net sales ratio) and X_{13} (work-load assigned to each work) carry their respective highest loadings on this factor. Except X_{13}, the other two variables carry reasonably high values of h^2. The value of h^2(= 0.262) for the variable X_{13} implies

that the five extracted factors do not carry adequate power to explain the variation of this variable. It is concluded that F_4 is primarily being influenced by X_1 and X_{10} and, therefore, may be interpreted as 'profitability factor'.

Factor 5 (F_5) : This factor accounts for 10.90% of the total variation. Only the variable X_{11} (net sales to total asset ratio) carries its highest loading on this factor. This variable has a high value for communality; $h^2 \approx 0.816$. The factor, F_4, may be interpreted as 'yield factor'.

After obtaining the factor loadings of the various variables given in Table 6.4, we next proceed to calculate the factor score coefficients given in Table 6.5. The factor score coefficient matrix has been computed using the factor loadings given in Table 6.4 and the original correlation matrix presented in Table 6.1. The final step is to develop factor score scales for the 5 extracted factors which represent the yearly performance of each mill which was originally being characterized by the 14 attributes. The 5 factor scales are obtained by multiplying the factor score coefficients by the Z scores of the mill's attributes. These are:

TABLE 6.5 : Factor Score Coefficient Matrix

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
X_1	-0.00892	0.02316	-0.08360	0.13410	0.09124
X_2	0.64592	-0.21202	0.05372	-0.20963	0.10797
X_3	0.16636	0.05413	-0.15394	-0.07182	0.06159
X_4	0.26369	0.03846	0.00739	0.07533	-0.02533
X_5	-0.14926	0.93891	-0.12358	-0.02053	-0.58675
X_6	-0.08364	-0.00664	0.21200	0.03405	-0.08459
X_7	0.00301	-0.02365	0.40204	-0.13143	0.11253
X_8	0.01573	0.01355	-0.47179	-0.15581	-0.14789
X_9	0.04544	0.08585	-0.00195	0.00317	0.42590
X_{10}	-0.02638	-0.05363	-0.06607	0.78025	-0.08106
X_{11}	-0.00778	0.21115	-0.08544	0.12197	0.64014
X_{12}	0.00678	-0.02570	-0.02373	0.05125	0.01099
X_{13}	-0.04399	-0.03937	0.00313	0.04263	-0.04289
X_{14}	0.00443	0.05036	0.02709	-0.03353	0.04712

$$f_1 = -0.00892\ z_1 + 0.64592\ z_2 + 0.16636\ z_3 + 0.26369\ z_4$$
$$-0.14926\ z_5 - 0.08364\ z_6 + 0.00301\ z_7 + 0.01573\ z_8$$
$$+0.04544\ z_9 - 0.02638\ z_{10} - 0.00778\ z_{11} + 0.00678\ z_{12}$$
$$-0.04399\ z_{13} + 0.00443\ z_{14}$$

$$f_2 = 0.02316\ z_1 - 0.21202\ z_2 + 0.05413\ z_3 + 0.03846\ z_4$$
$$+ 0.93891\ z_5 - 0.00664\ z_6 - 0.02365\ z_7 + 0.01355\ z_8$$
$$+ 0.08585\ z_9 - 0.05363\ z_{10} + 0.21115\ z_{11} - 0.02570\ z_{12}$$
$$- 0.03937\ z_{13} + 0.05036\ z_{14}$$

$$f_3 = -0.08360\ z_1 + 0.05372\ z_2 - 0.15394\ z_3 + 0.00739\ z_4$$
$$- 0.12358\ z_5 + 0.2120\ \ z_6 + 0.40204\ z_7 - 0.47179\ z_8$$
$$- 0.00195\ z_9 - 0.06607\ z_{10} - 0.08544\ z_{11} - 0.02373\ z_{12}$$
$$+ 0.00313\ z_{13} + 0.02709\ z_{14}$$

$$f_4 = 0.1341\ z_1 - 0.20963\ z_2 - 0.07182\ z_3 + 0.07533\ z_4$$
$$- 0.02053\ z_5 + 0.03405\ z_6 - 0.13143\ z_7 - 0.15581\ z_8$$
$$+ 0.00317\ z_9 + 0.78025\ z_{10} + 0.12197\ z_{11} + 0.05125\ z_{12}$$
$$+ 0.04263\ z_{13} - 0.03353\ z_{14}$$

$$f_5 = 0.09124\ z_1 + 0.10797\ z_2 + 0.06159\ z_3 - 0.02533\ z_4$$
$$- 0.68675\ z_5 - 0.08459\ z_6 + 0.11253\ z_7 - 0.14789\ z_8$$
$$+ 0.42590\ z_9 - 0.08106\ z_{10} + 0.64014\ z_{11} + 0.01099\ z_{12}$$
$$- 0.04289\ z_{13} + 0.04712\ z_{14}$$

It may be pointed out that the five extracted factors (F_1, F_2, F_3, F_4 and F_5) are the hypothetical constructs (surrogates) of the short term (yearly) performance characteristics of a mill. Further, f_1, f_2, f_3, f_4 and f_5 are the factor scores of the corresponding surrogates reflecting the contributions of the 14 attributes in varying degrees. We have computed the yearly factor scores for all the sampled mills for the period April 1971 - March 1981. However, in order to conserve on space, only the factor scores for the year 1980-81 are presented in Table 6.6.

6.1.3. Development of Weighted Short-term Performance Surrogate (WSPS)

In section 6.1.2, we have used the technique of factor analysis to extract the five factors, F_1, F_2, F_3, F_4 and F_5, which represent the short term performance attributes. It may be noted that these factors are orthogonal to each other and were considered to be equally important to measure the short term performance of a mill. However, Nie et.al. (1975) have suggested that the importance of a factor may be evaluated by examining the proportion of the total variance accounted for by each factor. Davies & Thompson (1980) have used such a weighting procedure for deciding the priorities of the **diodic** system in urban

TABLE 6.6: Factor Scores of Sampled Mills for 1980-81

Sl.No.	Mill code	f_1	f_2	f_3	f_4	f_5
1	1101	-.05	-.02	-.61	.87	.54
2	1102	-.30	.001	-.70	.32	.81
3	1103	-.45	-.08	-.77	.15	.41
4	1104	-1.12	.51	-.63	.36	-.18
5	4105	-1.17	2.30	.24	.08	.38
6	2106	.22	1.62	-.17	.13	-.81
7	4107	-.74	.28	-1.25	1.06	2.48
8	1108	-.89	.36	-.51	-.67	-.34
9	3109	-.22	-.03	.10	.34	.32
10	3110	-.11	.12	.14	.32	.04
11	4111	1.12	.04	-1.69	.25	2.37
12	2112	-.32	.28	-.80	.07	.53
13	2113	-.21	.36	-1.14	-.11	-.06
14	4114	-.11	-.29	.66	.55	1.76
15	4115	1.06	2.42	-1.35	.23	-.16
16	2116	-.25	.27	-.30	.61	-1.19
17	1117	-.51	.50	.44	.71	.83
* 18	1118	-.89	.32	-1.25	.35	1.78
19	1119	.03	-.21	-.24	.92	-.34
20	1120	-1.06	.32	-.95	.42	1.21
21	2121	-1.6	-.08	-.92	-1.2	-.53
22	4122	.46	-.17	-2.24	.08	.27
23	4123	1.43	-.02	-.89	.02	1.16
24	2124	-.16	1.05	.15	.48	-.32

TABLE 6.6: (continued)

25	1125	−1.27	.17	− .94	.43	1.07
26	1126	− .11	− .10	− .49	.67	.01
27	2127	− .34	.24	− .25	− .24	.63
28	3128	− .22	− .12	− .75	− .45	− .67
* 29	3129	.08	− .67	−1.14	.93	−1.36
30	2330	.27	.77	− .78	.67	.86
31	1132	.66	− .07	.89	1.10	.85
* 32	4133	−1.22	− .20	.27	−1.66	− .23
33	4234	− .77	.32	−1.2	.70	− .28
34	2135	.03	1.07	− .04	.79	.67
35	3136	− .25	− .21	− .46	1.12	− .05
* 36	2137	− .73	− .30	− .79	−1.91	.11
37	2138	−1.03	.02	.65	−3.13	− .92
38	2139	− .78	− .001	− .49	− .22	.82
39	2140	− .76	− .15	− .69	−1.27	− .44
40	1141	− .14	− .40	.64	−1.95	.67
41	2142	−1.01	.35	− .89	.16	.006
42	3137	− .49	− .08	1.06	1.05	− .03
43	3234	.10	.04	− .36	.17	.09
44	4201	.04	− .11	− .51	.71	.50
45	1102	− .45	− .06	− .25	1.43	− .59
46	1203	− .38	− .20	.03	1.49	.68
47	3205	.45	2.19	.38	.40	− .06
48	3206	− .12	.24	− .17	.36	.89
49	2207	− .23	.50	.18	.006	.60
50	3208	− .39	− .09	.29	.78	− .07

TABLE 6.6 (continued)

51	3209	.15	− .75	− .31	2.86	− .89
52	3210	2.43	3.87	−1.89	− .20	−1.46
53	4211	.16	− .63	1.28	2.01	−1.46
54	3212	− .06	− .21	.29	.84	1.08
55	3213	− .40	2.19	.12	1.03	− .74
56	2214	− .15	− .12	.01	.79	− .58
57	3215	.10	.09	.61	2.03	.77
58	3216	.08	.52	.65	.37	.16
59	2217	− .60	.07	.30	.75	1.80
60	2218	− .75	3.47	− .15	.08	−1.46
61	4219	− .13	.54	− .24	.38	.06
62	3220	− .31	.66	.26	1.26	− .68
63	3221	− .71	− .36	− .61	1.75	− .54
64	3222	.20	− .82	.65	1.42	− .76
65	3223	.60	− .22	− .18	.66	1.29
66	3224	− .66	− .13	.01	1.79	− .01
67	3225	.26	.56	.18	.71	.06
68	2226	.91	.94	.69	.05	.28
69	4227	2.54	.32	− .55	.32	1.01
70	4228	.10	.38	.19	1.13	.93
71	3229	.30	− .70	1.02	− .13	.45
72	1230	.49	− .31	− .53	2.06	1.76
73	3231	1.16	.17	.29	1.32	−1.32
74	4232	− .64	.66	.82	− .01	− .47
75	4233	− .22	.32	.54	1.01	− .32

transport. This has motivated us to develop a unitary measure of short term performance, F*, to be called 'Weighted Short Term Performance Score'. It is given by

$$F^* = \sum_{j=1}^{J} w_j f_j$$

where

$$w_j = \frac{\lambda_1^*}{\sum_{j=1}^{J} \lambda_j}$$

J is the number of extracted factors and λ_j is the eigen value of the jth factor.

Using the eigen values associated with the five factors, given in Table 6.4, we obtain the following relationship for F*.

$$F^* = 0.381 \; f_1 + 0.2 \; f_2 + 0.175 \; f_3 + 0.135 \; f_4$$
$$+ \; 0.109 \; f_5 \; .$$

F* may be interpreted as a surrogate which is a composite of the short term performance characteristics of a mill. The F* scores for the year 1980-81 for all the sampled mills are calculated using f_j (j = 1, 2, ..., 5) values given Table 6.6 and are presented in Table 6.7.

TABLE 6.7: Scores of Weighted Short-term Performance
Surrogate of Sampled Mills for 1980-81

Sl.No.	Mill code	WSPS Score, F*	Sl.No.	Mill code	WSPS Score F*
1	1101	0.046	22	4122	-0.210
2	1102	-0.105	23	4123	0.514
3	1103	-0.122	24	2124	0.205
4	4104	-0.396	25	1125	-0.439
5	4105	0.108	26	4126	-0.056
6	2106	0.202	27	2127	-0.088
7	4107	-0.031	28	3128	-0.363
8	1108	-0.484	29	3129	-0.333
9	3109	0.01	30	3130	0.305
10	3110	0.050			
			31	1132	0.449
11	4111	0.403	32	4133	-0.701
12	2112	-0.139	33	4134	-0.375
13	2113	-0.227	34	2135	0.398
14	4114	0.282	35	3136	0.072
15	4115	0.284	36	2137	0.711
16	2116	-0.141	37	2138	-0.797
17	1117	0.015	38	2139	-0.319
18	1118	-0.252	39	2140	-0.659
19	1119	0.012	40	1141	-0.208
20	1120	-0.317			
			41	2142	-0.448
21	2121	-0.995	42	3137	-0.136

TABLE 6.7 (Continued)

43	3234	0.016	60	2218	0.233
44	4201	0.061			
45	1202	0.101	61	4219	0.074
46	1203	0.095	62	3220	0.155
47	3205	0.715	63	3221	-0.272
48	3206	0.118	64	3222	0.135
49	2207	0.110	65	3223	0.383
50	3208	-0.011	66	3224	-0.035
			67	3225	0.345
51	3209	0.142	68	2226	0.693
52	3210	0.940	69	4227	1.088
53	4211	0.271	70	4228	0.401
54	4212	0.262			
55	3213	-0.365	71	3229	0.173
56	2214	0.036	72	1230	0.502
57	3215	0.509	73	3231	0.561
58	3216	0.315	74	4232	-0.021
59	2217	0.135	75	4233	0.17

6.2. Long-term Performance Surrogates

In the financial literature the measurement of business risk is considered to be an important surrogate reflecting the impact of the environmental parameters on the performance of an industrial unit. However, Wilcox (1980) has suggested that the concepts of stability and resilience can create a greater awareness for the managers of the importance and impact of the external factors present in the environment, factors over which the manager has no control. Further, the manager can use the information in business risk, stability, and resilience for better decision making and as parameters for measuring and monitoring the responsive capability of the organization to environmental change. Keeping the foregoing discussion in view we have selected measures based on **risk, stability, and resilience** as the long-term performance surrogates of a textile mill.

6.2.1. Risk Measure

Business risk is measured in terms of the statistical variation in the rate of return before interest and depreciation. To the financial institutions and debtors the risk measure provides useful information as to the ability of an industrial unit to repay borrowed funds.

Researchers in the area of capital market instrument use the concept of risk to estimate the degree of uncertainty associated with respect to the realization of expected future rate of return (Colley, 1979). Business risk is measured in terms of Risk Coefficient (R_1) and is given by the following relationship:

$$R_1 = \frac{\sigma_{X_1}}{\overline{X_1}} \qquad ,$$

where σ_{X_1} = standard deviation in the rate of return before interest and depreciation,

$\overline{X}_1$ = average rate of return before interest and depreciation.

6.2.2. Stability Measure

Stability is the property of a system to return to an equilibrium state after a temporary disturbance; the more rapidly it return and less it fluctuates, the more stable it would be. Thus it represents the ability of an industrial organization to maintain a steady state inspite of small or temporary perturbations. It is measured in terms of Stability Coefficient, (R_2) defined by

$$R_2 = \frac{CV_{X9}}{R_1} \qquad ,$$

where CV_{X_9} is the coefficient of variation of sales and is defined as

$$CV_{X_9} = \frac{\sigma_{X_9}}{\bar{X}_9} \quad ,$$

where σ_{X_9} is the standard deviation and

$\bar{X}_9$ is the average sales

In the context of the present work, X_9 represents sales per equivalent spindle, as defined in Chapter V.

6.2.3. Resilience Measure

Resilience is defined as the property of a system which allows it to maintain a steady state inspite of large or permanent perturbations. The Resilience Coefficient (R_3) is computed using the following relationship

$$R_3 = \frac{CV_{X_9}}{CV_{X_5}} \quad ,$$

Where CV_{X_5} is the coefficient of variation of the invested capital and is defined as

$$CV_{X_5} = \frac{\sigma_{X_5}}{\bar{X}_5}$$

where σ_{X_5} is the standard deviation of the total assets (invested capital).

In the context of the present study, X_5 represents total assets per equivalent spindle.

The distinction between the two surrogates, viz., Stability and Resilience lies in the fact that a more stable firm absorbs fluctuations in sales with minimal fluctuation in the rate of return, while a more resilient firm can absorb large fluctuations in sales with minimal fluctuation in the invested capital.

The surrogates, R_1, R_2, and R_3 have been computed for the 75 sampled mills considering the data for the period April 1971 - March 1981. The values of the surrogates thus obtained are presented in Table 6.8.

6.3. Relationships among Mill Performance Surrogates

The various surrogates, viz., f^*, R_1, R_2, and R_3 given in Tables 6.7 and 6.8 have been examined for possible relationships amongst them. Table 6.9 gives the correlation coefficients amongst the various surrogates and the corresponding levels of significance. It is observed that Risk and Stability coefficients are the only surrogates which have significant relationship with each other.

TABLE 6.8 : Values of Risk, Stability and Resilience
Coefficients for Sampled Mills.

Sl.No.	Mill code	Risk Coefficient, R_1	Stability Coefficient, R_2	Resilience Coefficient, R_3
1	1101	1.28	0.23	1.36
2	1102	1.05	0.32	1.97
3	1103	1.06	0.36	1.58
4	1104	0.84	0.41	1.04
5	1105	1.29	0.17	0.61
6	2106	0.19	1.97	0.93
7	4107	0.83	0.09	1.43
8	1108	2.36	0.01	1.52
9	3109	0.15	2.92	1.91
10	3110	0.84	0.99	1.00
11	4111	1.68	0.19	1.33
12	2112	0.61	0.57	1.47
13	2113	0.30	1.30	0.84
14	4114	2.40	0.09	1.21
15	4115	0.26	2.20	1.24
16	2116	0.38	1.15	1.35
17	1117	1.29	0.58	1.11
18	1118	0.98	0.23	1.43
19	1119	0.35	0.81	1.17
20	1120	1.49	0.12	0.83
21	2121	3.48	0.11	1.34
22	4122	2.55	0.09	1.17
23	4123	0.72	0.41	1.61

TABLE 6.8 (continued)

24	2124	0.19	2.34	0.99
25	1125	6.18	0.06	1.35
26	1126	0.49	0.75	1.09
27	2127	0.18	0.98	0.88
28	3128	0.75	0.34	0.74
29	3129	1.30	0.25	1.06
30	2330	0.19	2.95	2.21
31	1132	0.88	0.51	0.20
32	4133	8.45	0.02	1.61
33	4234	0.85	0.44	1.05
34	2135	0.30	1.38	1.15
35	3136	0.70	0.62	0.97
36	2137	10.16	0.01	1.08
37	2138	2.81	0.10	1.01
38	2139	1.06	0.23	1.23
39	2140	1.65	0.23	1.23
40	1141	2.78	0.09	2.86
41	2142	1.06	0.33	1.79
42	3137	0.79	0.38	1.20
43	3234	1.27	0.31	3.13
44	4201	1.43	0.42	1.83
45	1202	0.93	0.32	1.05
46	1203	1.06	0.27	2.51
47	3205	0.99	0.47	0.94
48	3206	0.40	1.39	0.54
49	2207	0.31	0.92	1.59
50	3208	0.55	0.68	0.94

TABLE 6.8 (continued)

51.	3209	0.58	0.64	1.21
52	3210	0.72	0.45	1.07
53	4211	0.28	1.02	1.49
54	3212	0.34	0.97	1.08
55	3213	0.45	0.71	0.63
56	2214	0.49	0.62	0.83
57	3215	0.28	1.19	0.95
58	3216	0.50	0.83	1.03
59	2217	0.96	0.11	0.60
60	2218	2.97	0.04	0.44
61	4219	0.11	4.53	0.81
62	3220	0.94	0.19	0.71
63	3221	1.07	0.31	1.27
64	3222	0.89	0.41	0.66
65	3223	0.62	0.50	0.94
66	3224	1.31	0.22	1.35
67	3225	0.53	0.76	0.92
68	2226	0.39	1.11	1.29
69	4227	0.48	0.49	1.47
70	4228	1.39	0.22	3.06
71	3229	0.36	1.03	0.99
72	1230	1.47	0.42	2.43
73	3231	3.63	0.05	0.92
74	4232	0.41	0.71	1.17
75	4233	1.37	0.20	1.66

TABLE 6.9 : Correlation Coefficients between WSPS Score (f✱), Risk (R_1), Stability (R_2), and Resilience (R_3) for the Sampled Mills.

	f✱	R_1	R_2	R_3
f✱	1	-.390 (.420)	.429 (.3207)	-.175 (.211)
R_1	-.390 (.420)	1	-.621 (.00001)	-.205 (.10024)
R_2	.424 (.3210)	-.621 (.00001)	1	-.108 (.4076)
R_3	-.175 (.211)	-.205 (.10024)	-.108 (.4078)	1

The values in bracket indicate the level of significance.

6.3.1. Relationship between Risk and Stability Coefficients

Figure 6.1 shows a bivariate scatter gram of Risk coefficient Vs. Stability Coefficient for the 75 sampled mills. This plot suggests the existence of the following relationship between the two surrogates.

$$R_2 = 0.2897 \ R_1^{0.753}$$

The F-value, being 387.57, is highly significant at 1% level of significance and indicates that the above fitted model is adequate. The basic assumption underlying this model is that the two types of textile mills, viz., the composite and spinning have identical performance behaviour with respect to Risk and Stability coefficients. In order to test this assumption we have considered the two surrogates for the two types of mills separately.

Figures 6.2 and 6.3 show the bivariate scatter plots and the regression relationships for the two cases:

(i)   Considering 42 composite mills in the sample

$$R_2 = 0.2904 \ R_1^{0.752}$$

(ii)   Based on a sample of 33 spinning mills

$$R_2 = 0.2904 \ R_1^{0.755}$$

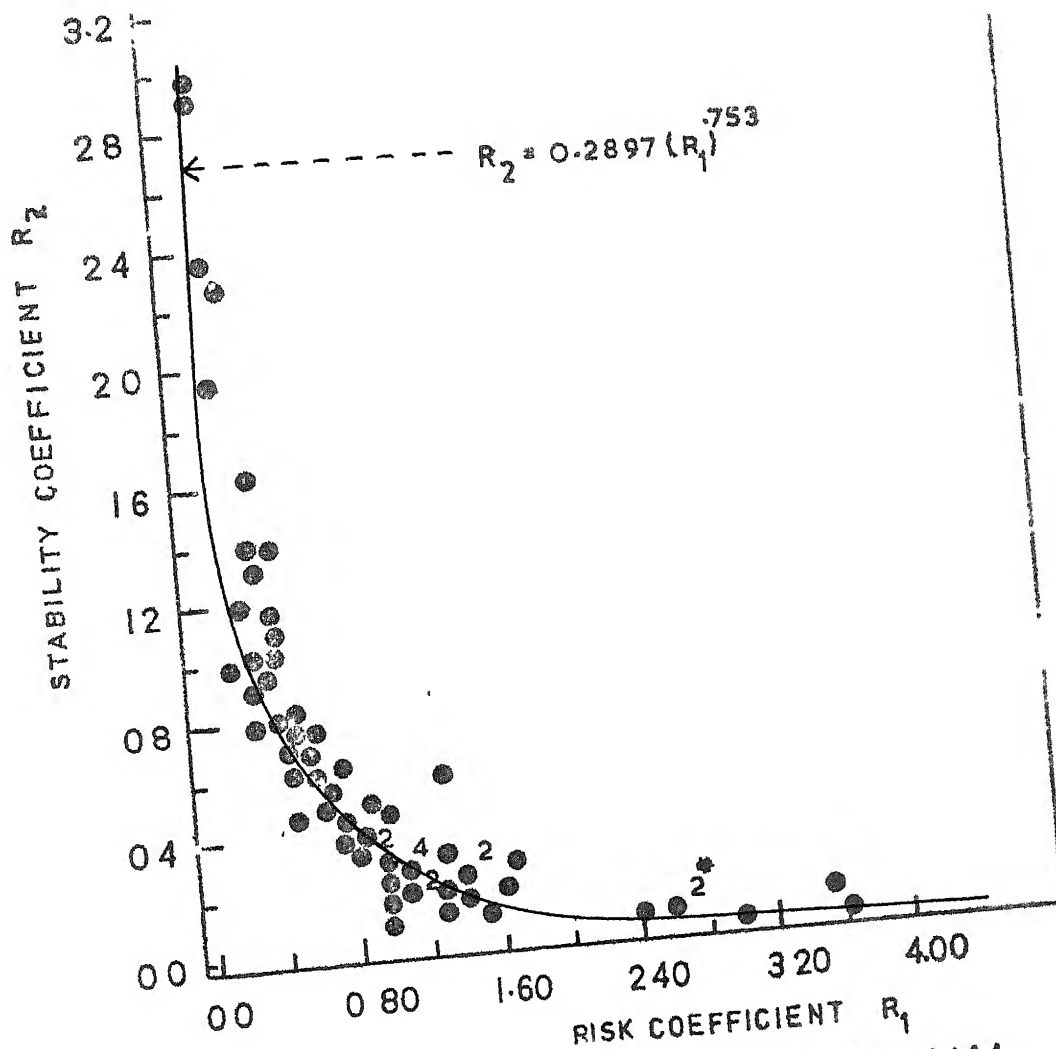FIGURE 6·1. RISK VS. STABILITY SCATTERGRAM
FOR SAMPLED MILLS.
* THE NUMBER INDICATES FREQUENCY OF
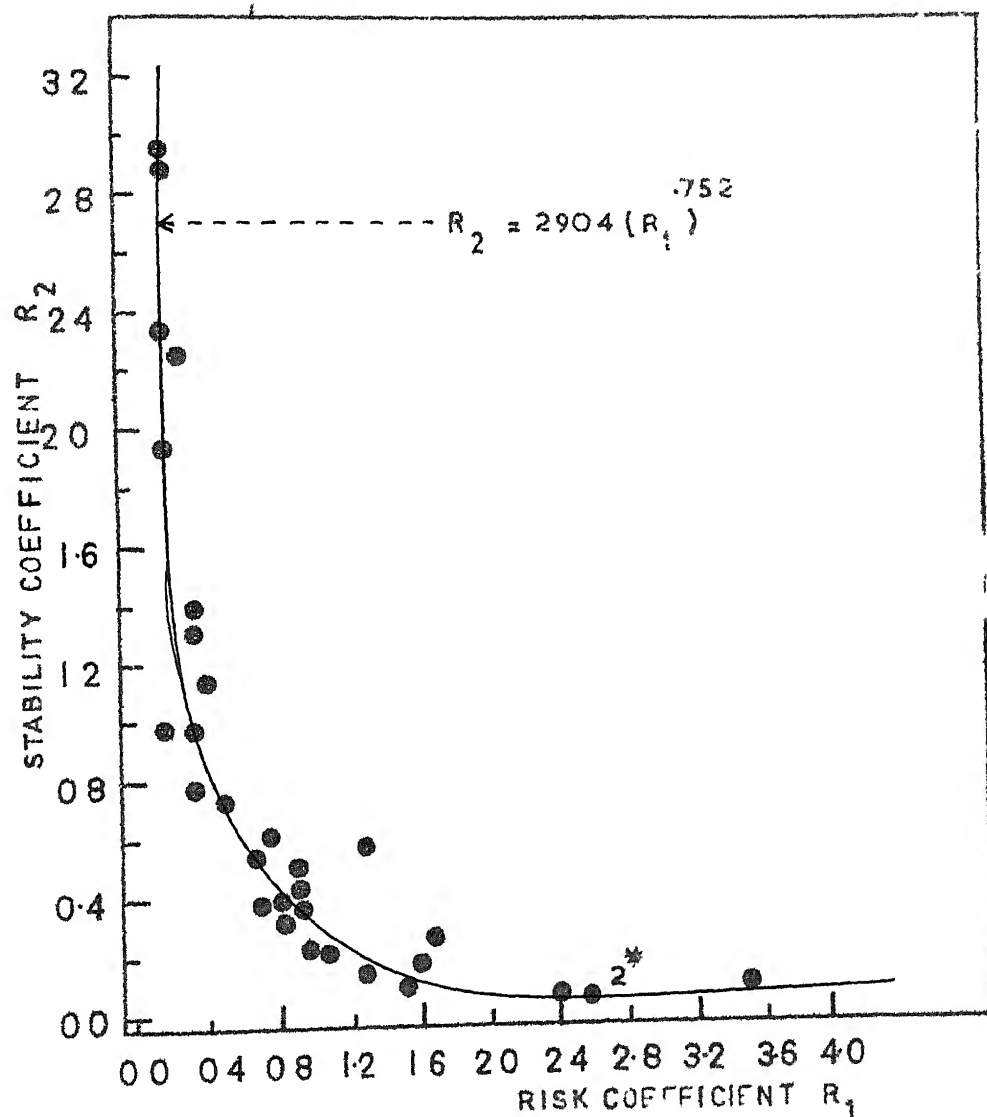MILLS HAVING SAME VALUE.

FIGURE 6·2. RISK VS. STABILITY SCATTERGRAM
FOR COMPOSITE MILLS IN THE SAMPLE.
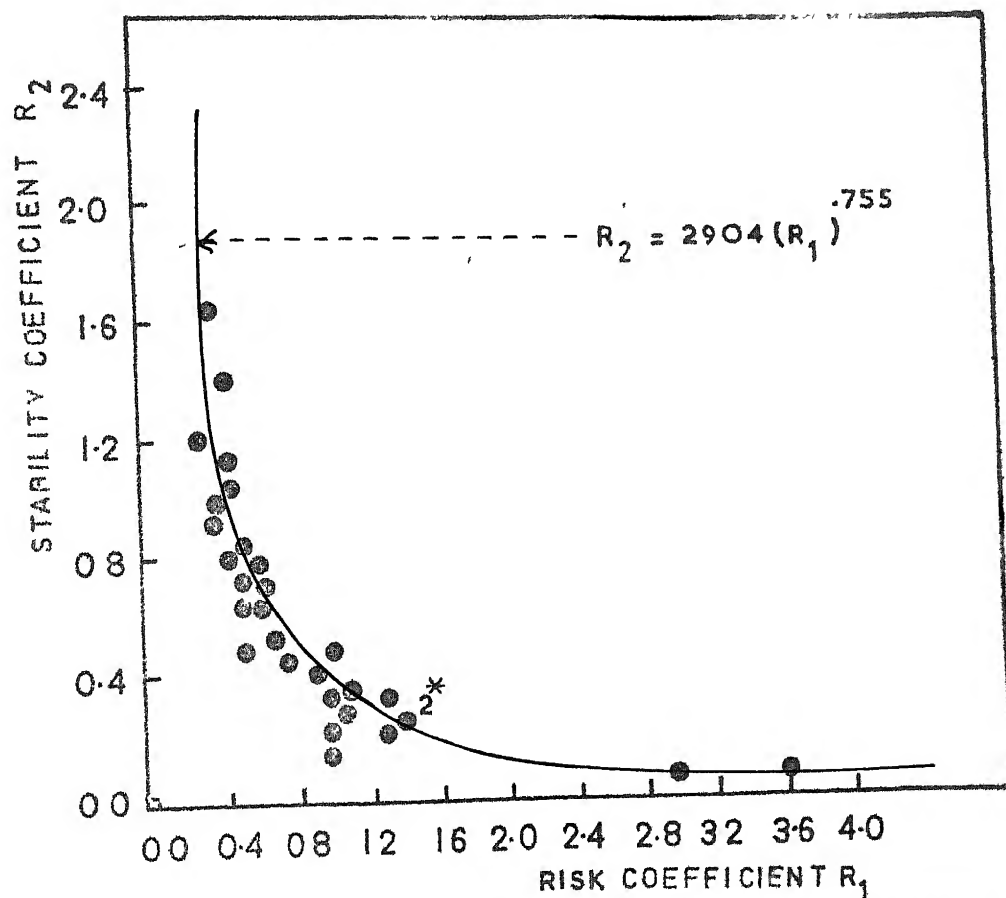* THE NUMBER INDICATES FREQUENCY OF
MILLS HAVING SAME VALUE.

FIGURE 6·3. RISK VS. STABILITY SCATTERGRAM
FOR SPINNING MILLS IN THE SAMPLE.

✳ THE NUMBERS INDICATES FREQUNCY OF
MILLS HAVING SAME VALUE.

The goodness of fit in both the cases is assured by highly significant values of F, being 208.59 and 155.97, respectively.

6.4. Model for the Assessment of Health Status

The ultimate objective of the present work is to develop a univariate measure to establish the health status of a textile mill considering both the short-term and the long-term performance surrogates. In Section 6.1 we developed five surrogates F_1, F_2, F_3, F_4, and F_5 to represent the 14 short-term performance attributes. Further, a weighted short-term performance surrogate, F^* was obtained through a linear combination of the five factor scores. The long-term performance of a mill was measured in terms of Risk, Stability, and Resilience Coefficients. Considering suitable combination of the short-term and long-term surrogates we wish to develop a model for assessing the health status of a mill. Indirectly this implies that the model should be able to discriminate a sick mill from a healthy one. This is done through Discriminant Analysis. In the following sub-section a brief description of the technique is presented. For a detailed theoretical treatment of the subject, the reader may refer to Cooley and Lohnes (1971), Bolch (1974), and Nie, et.al. (1975).

6.4.1. Discriminant Analysis

Discriminant Analysis attempts to differentiate between two or more groups of entities. To distinguish between the groups one has to select a set of discriminating variables that measure certain characteristics on which the groups are expected to differ. In discriminant analysis the discriminating variables are weighed and linearly combined so that the groups became statistically distinct as far as possible. Mathematically, a discriminant function based on p discriminating variables can be written as

$$Y_i = \alpha_{io} + \alpha_{i1} z_1 + \alpha_{i2} z_2 + \ldots\ldots + \alpha_{ip} z_p$$

where Y_i is the score on discriminant function i, the α are weighting coefficients and z_i, i = 1, ..., p are the standardized values of the p discriminating variables used in the analysis. The functions are founed such that the separation of the groups is maximized. The maximum number of functions which can be derived is either one less than the number of groups or equal to the number of discriminating variables if the number of groups is greater than the number of variables involved in the analysis. The discriminating power of the discriminant functions based on

different sets of variables is evaluated in terms of
Wilk's $\wedge$ values and the percentage of cases correctly
classified (Nie et.al. 1975, p. 440). Lower value of
Wilk's $\wedge$ suggests higher discriminating power of the
discriminant functions. Similarly, if a large percentage of
misclassification occurs, then the variables selected are
poor discriminators.

The discriminant function finally selected on this
basis can be used to classify an unknown case into one or
the other group. This is done by comparing the discriminant
score of an entity with the cut-off value Y^* which is the
mid point of the centroids of the two groups being discri-
minated.

6.4.2. Selection of a Sample of Healthy and Sick Mills

For developing a discriminant function which can
classify the mills into "healthy" and "sick", we require a
sample of mills with proven record of being healthy or sick.
A set of 17 mills were identified amongst the 75 sampled
mills which could be classified into one of these two
categories. To this end, the necessary information was
sought from the Special Sickness Monitoring Cell of the
RBI, Bombay and the Stack Exchange Foundations Official
Directory. The sample of the 17 identified mills comprised

of 10 healthy and 7 sick mills. Appendix C gives, in brief, the performance case history of the seven sick mills. In order to ensure the correctness of the information the rate of return before interest and depriciation (X_1) for these mills during the period 1971 to 1980 was examined. The same is presented in Figure 6.4. It is observed that the mills in the sick group exhibited marked fluctuations in the values of X_1, whereas a steady trend dominated the healthy group of mills.

6.4.3. Development of Discriminant Function

We wish to develop the discriminant function based on two types of surrogates. The first set comprises the five factors or then weighted combination which reflect the short-term performance of a mill while the second set consists of the long-term performance surrogates; risk, stability, and resilience. These surrogates are considered in several combinations with a view to select the set of surrogates which possess the best discriminating power. However, it may be noted that in a combination in which the short-term performance surrogates appear, we will either consider the five factors together or their weighted combination. In all 19 combinations were tried. The analysis is done using the subprogram, 'DISCRIMINANT', of
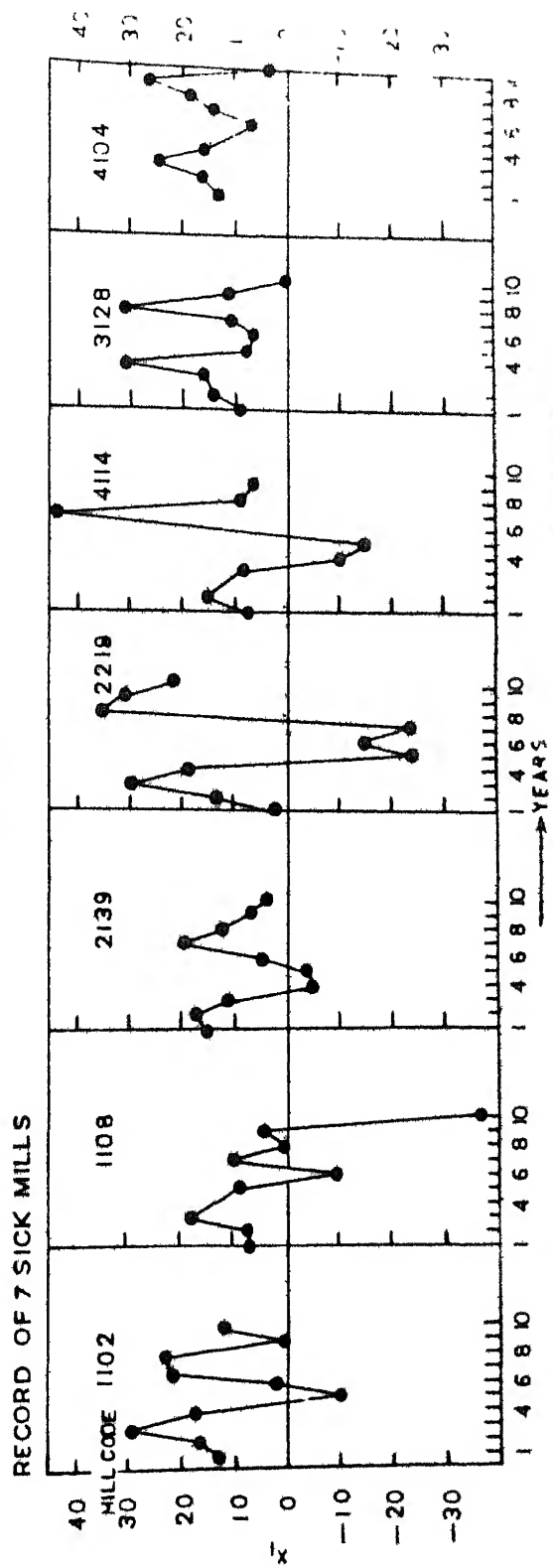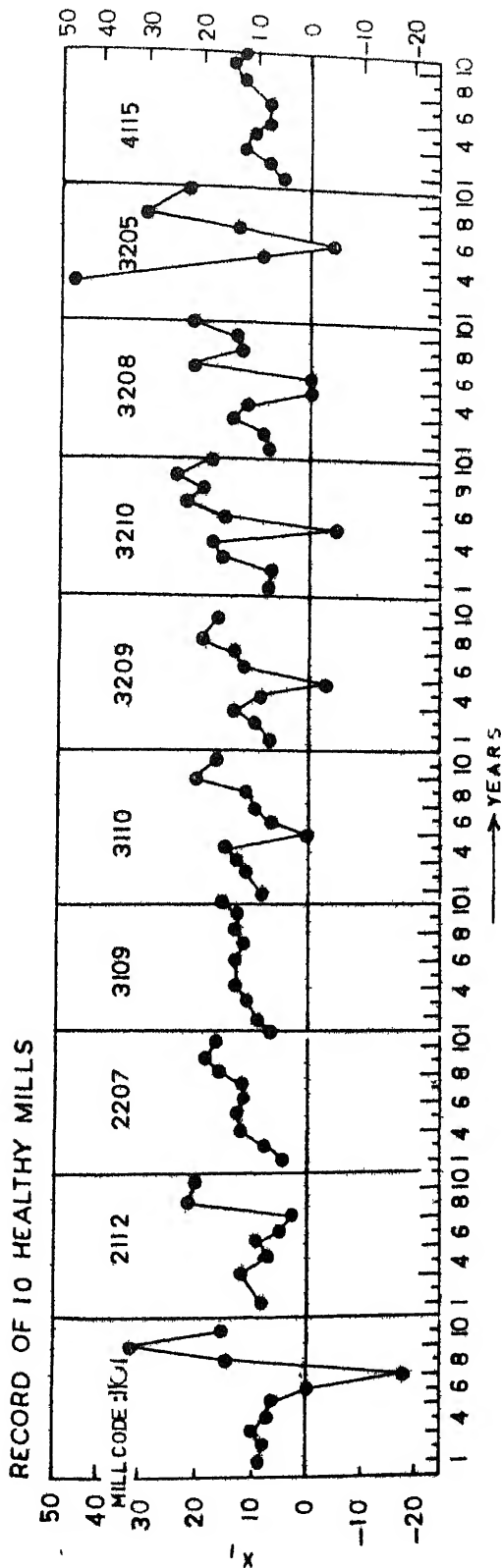
FIGURE 6.4. RATE OF RETURN BEFORE INTEREST AND DEPRECIATION (X₁) PLOT FOR 17 MILLS (10 HEALTHY AND 7 SICK MILLS).

TABLE 6.10 : Results of Discriminant Analysis with Various Combination of Surrogates.

Sl.No.	Combination	Wilk's $\wedge$	%age of Mills correctly classified
1.	R_1, R_2	0.74	76
2.	R_2, R_3	0.782	71
3.	R_1, R_3	0.793	65
4.	R_1, R_2, R_3	0.741	76
5.	F_1, F_2, F_3, F_4, F_5	0.573	60
6.	F_1, F_2, F_3, F_4, F_5, R_1	0.407	94
7.	F_1, F_2, F_3, F_4, F_5, R_2	0.408	88
8.	F_1, F_2, F_3, F_4, F_5, R_3	0.563	70
9.	F_1, F_2, F_3, F_4, F_5, R_1, R_2	0.379	94
10.	F_1, F_2, F_3, F_4, F_5, R_1, R_3	0.407	94
11.	F_1, F_2, F_3, F_4, F_5, R_2, R_3	0.395	88
12.	F_1, F_2, F_3, F_4, F_5, R_1, R_2, R_3	0.373	100
13.	F^*, R_1	0.419	88
14.	F^*, R_2	0.596	76
15.	F^*, R_3	0.710	71
16.	F^*, R_1, R_2	0.741	85
17.	F^*, R_1, R_3	0.570	88
18.	F^*, R_2, R_3	0.585	71
19.	F^*, R_1. R_2, R_3	0.545	82

If the discriminant score Y of a mill is less than 0.138, it should be declared healthy. On the other hand, the sick mills will have Y > 0.138.

6.5. Assessment of Health Status of Sampled Mills

Table 6.11 shows the discriminant score Y for all the 75 mills in the sample based on the discriminant function developed in the previous section. The cut-off value of 0.138 splitted the sample into two groups consisting of 50 healthy and 25 sick mills, respectively. The first set of 42 mills shown in Table 6.11 are the composite mills. It is observed that the mix in terms of the number of healthy and sick mills is 22 and 20, respectively. The last set of 33 mills, representing spinning units, consists of 28 healthy and 5 sicks mills as identified by the discriminant model. Thus, it appears that even amongst the textile mills, the sickness is more prevalent in the composite mills as compared to the spinning mills. Figure 6.4 portrays the status of the sampled mills in a comparative parlance.

Figure 6.5 depicts the flow chart for declaring a mill sick or healthy. The basic input information required is :

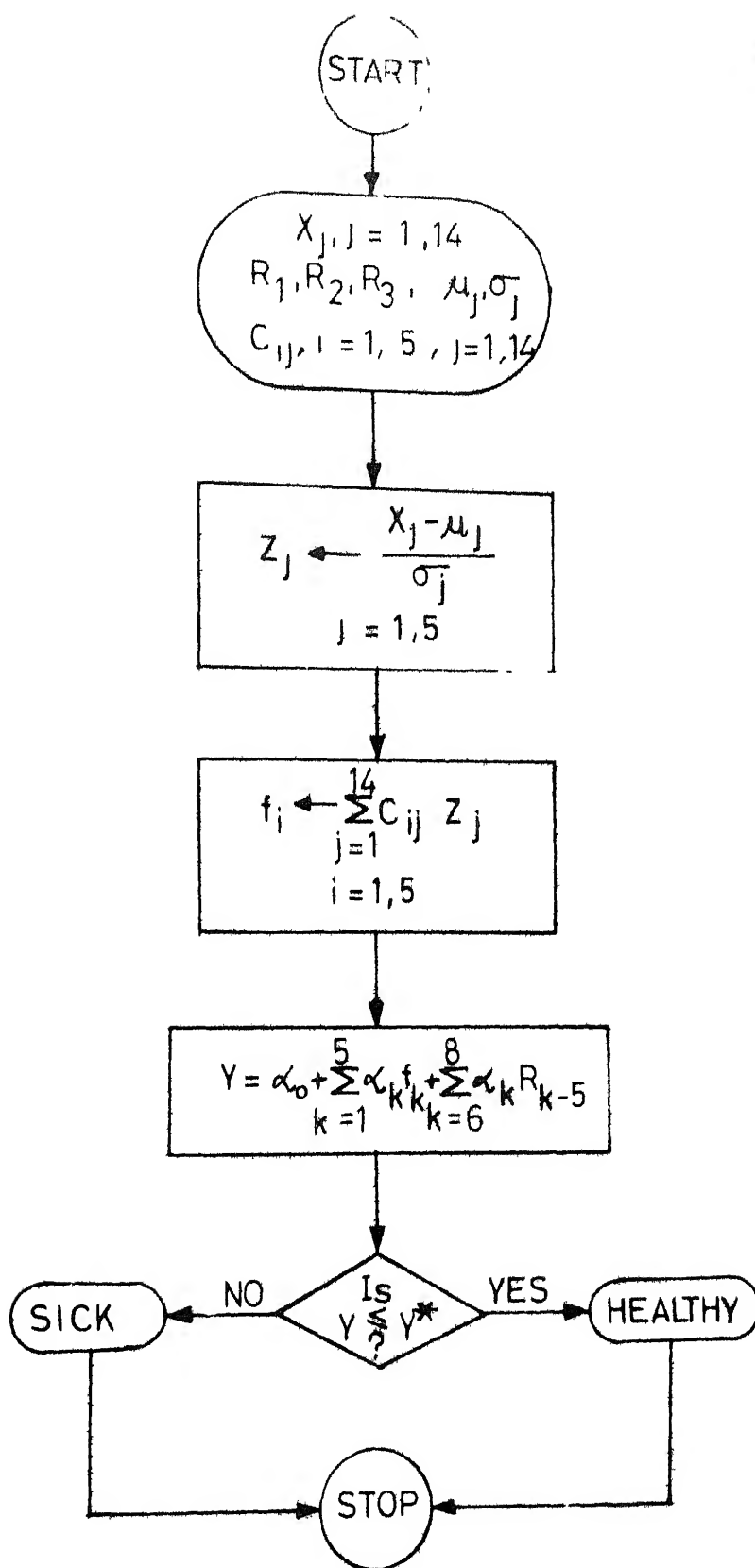1. Values of short-term attributes, X_j (j = 1, 2, ..., 14)

FIGURE 6·5 DECISION FLOW CHART FOR DECLARING
A MILL SICK

TABLE 6.11 : Discriminant Score (Y) of Sampled Mills.
The Symbol S and H indicate whether the
Mill is Sick or Healthy.

Sl.No.	Mill code	Discriminant Score, Y	Health Status	Sl.No.	Mill code	Discriminant Score, Y	Health Status
1	1101	−0.159	H	22	4122	0.593	S
2	1102	0.341	S	23	4123	−0.790	H
3	1103	0.591	S	24	4124	−1.147	H
4	4104	0.572	S	25	1125	2.380	S
5	4105	0.364	S	26	4126	−0.365	H
6	2106	−0.866	H	27	2127	−0.232	H
7	4107	−1.083	H	28	3128	0.953	S
8	1108	2.295	S	29	3129	0.569	S
9	3109	−0.999	H	30	2130	−1.904	H
10	3110	−0.110	H				
				31	1132	−0.971	H
11	4110	−1.124	H	32	4133	5.718	S
12	2112	0.095	H	33	4134	0.159	S
13	2113	−0.337	H	34	2135	−1.386	H
14	4114	0.192	S	35	3136	−0.475	H
15	4115	−1.481	H	36	2137	5.830	S
16	2116	0.116	H	37	2138	4.596	S
17	1117	−0.202	H	38	2139	0.770	S
18	1118	−0.183	H	39	2140	3.180	S
19	1119	−0.448	H	40	1141	3.383	S
20	1120	0.158	S				
				41	2142	1.006	S
21	2121	3.487	S	42	3137	0.094	H

TABLE 6.11 (Continued)

43	3234	1.180	S	60	2218	1.336	S
44	4201	0.108	H	61	4219	−2.356	H
45	1202	−0.095	H	62	3220	−0.165	H
46	1203	−0.036	H	63	3221	−0.056	H
47	3205	−0.548	H	64	3222	−0.260	H
48	3206	−1.142	H	65	3223	−1.109	H
49	2207	−0.086	H	66	3224	−0.160	H
50	3208	−0.176	H	67	3225	−0.721	H
				68	2226	−0.754	H
51	3209	−1.376	H	69	4227	−1.708	H
52	3210	−1.148	H	70	4228	0.136	S
53	4211	−0.501	H				
54	4212	−1.053	H	71	3229	−0.079	H
55	3213	−0.752	H	72	1230	−1.313	H
56	2214	−0.133	H	73	3230	0.650	S
57	3215	−2.073	H	74	4232	0.597	S
58	3216	−0.361	H	75	4233	0.435	S
59	2217	−0.654	H				

2. Risk, stability and resilience coefficients (R_1, R_2 & R_3) for the mill.

3. Mean and standard deviation of each attribute considering either all the mills in the industry or a random sample of mills; μ_j, σ_j (j=1, 2,....., 14).

4. Factor score coefficient, C_{ij} (i=1, ...5; j=1,2,...,14).

5. The values of the coefficients of the discriminant model, α_k (k=0, 1, ..., 8).

6. The cut-off value of Y, i.e., Y^*.

6.6. Some Observations on Results

(i) The five surrogates F_1, F_2, F_3, F_4, and F_5 extracted through factor analysis of the 14 short-term performance attributes can be interpreted as financial factor, assets and turnover strength factor, economic factor, profitability factor, and yield factor respectively. These surrogates can classify only 60% of the mills correctly.

(ii) The long-term surrogates R_1, R_2, and R_3 by themselves can correctly classify 76.4% of the mills. Risk and Stability coefficients (i.e., R_1 & R_2) bear an exponential relationship for the sampled mills. The values of the constant and exponent turned out

2. Risk, stability and resilience coefficients

$(R_1, R_2 \& R_3)$ for the mill.

3. Mean and standard deviation of each attribute

considering either all the mills in the industry or

a random sample of mills; μ_j, σ_j $(j=1, 2, \ldots, 14)$.

4. Factor score coefficient, C_{ij} $(i=1, \ldots 5; j=1,2,\ldots,14)$.

5. The values of the coefficients of the discriminant

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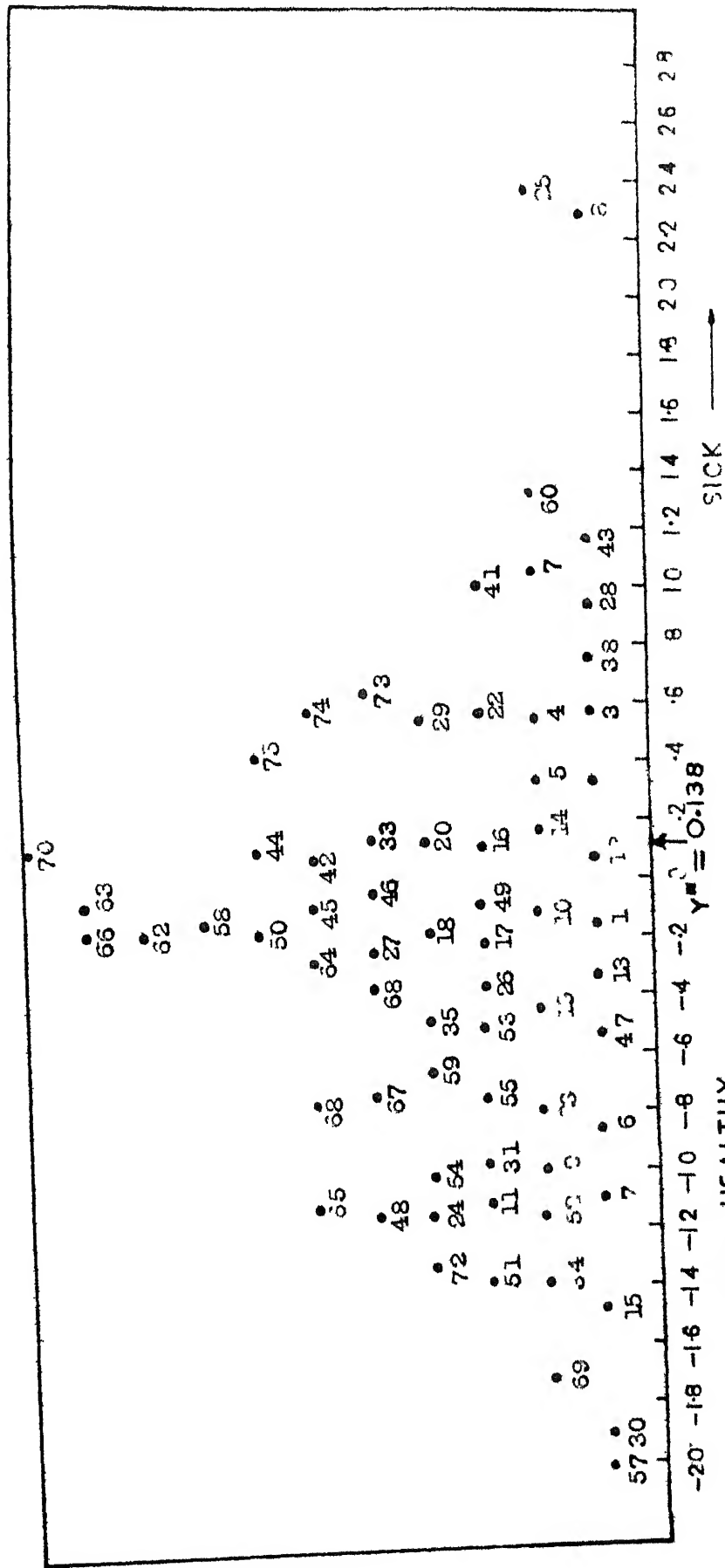The values of the constant and exponent turned out

FIGURE 6·6. HEALTH STATUS DISTRIBUTION OF SAMPLED MILLS

to be same when the composite mills and spinning mills were considered separately or together.

(iii) The surrogates F^*, R_1, R_2, R_3, provided 82.35% correct classification of the mills. The correct classification percentage increased to 100% when F_1, F_2, F_3, F_4, F_5, R_1, R_2 & R_3 surrogates were used for the development of the discriminant function.

(iv) From the observations (i), (ii) and (iii), it is concluded that both the short-term and long-term surrogates should be considered together for determining the health status of a textile mill.

(v) The value of Y score establishes the relative health status of a mill and provides answer to the question : how sick or healthy a textile mill is? A mill carrying very low score with respect to the cut-off value ($Y^* = 0.138$) indicates that the health status of the mill is very sound. Similarly, a high value of Y score compared to the cut-off value suggests that the mill is extremely sick.

(vi) The Y scores of the 75 mills in the sample for 1980-81 suggest that the mills bearing numbers 12, 16, 44, and 70 are marginally healthy. Unless, appropriate measures are undertaken by the management

and/or government agencies, these mills may become
sick in the future. Similarly, mills bearing
numbers 20 and 33 are only marginally sick and
can be salvaged through appropriate measures.

CHAPTER VII

CONCLUSIONS AND SCOPE FOR FURTHER WORK

7.1. Conclusions

(1)   The problem of sickness in the organized sector of the cotton textile **industry to** some extent, can be attributed to the conflicting objectives of the management and the government. The management of the mill- sector is mainly concerned with extracting the maximum returns out of the mills, while the government due to its socio-economic commitments tries to safeguard the interests of the workers. These conflicting objectives have contributed significantly to the retarded growth of the organized sector of the cotton textile industry.

(2)   **Over** the years, the government has patronised the non-organized handloom and powerloom sectors which have become a major competitors of the organized sector of cotton textile mills. In order to avoid the unhealthy competition the organized sector has no option but to modernize the machines and equipment for producing finer variety of cloth. Even these the government forbids the textile industry, since it will hit the handloom and powerloom sector. The domestic sale has gone down and exports have dropped over the years; costs have been rising faster than the price, for instance, the wages were up by

15%, cotton prices by 29%, and fuel prices by 23%. On the
whole the cost rose by 25% and cotton textile prices by
9%. As a result many of the mills have been making
losses ranging from Rs. 1 million to Rs. 3 million.

(3)   The causal system of sickness in cotton textile
industry is identified through set of 31 interacting
elements, including the elements representing sickness,
closure, and government take-over. The hierarchical
structure developed for the Interpretive Structural Model
(ISM)   suggested that the elements which primarily
reflect the government policy appear at the bottom of the
hierarchy. These elements would have maximum influence
on the system change. The bottom most elements identified
were: technical obsolescence and old machinery, general
inflation, government cotton policy, outstanding liabilities
of the mill; government credit policy, government develop-
ment efforts, and government production control policy.
The analysis of ISM to obtain the relative contextual
significant of each elements in terms of its responsiveness
to control, suggested that delayed payments, high price-
low quality product, poor quality cotton fibre and low
yield are the most important variables with respect to
these salience and control. The performance of a textile
mill needs to be assessed based on financial, economic,
and physical efficiency considerations. The short-term

performance of a mill is measured in term of 14 attributes, while the long-term performance can be evaluated through Risk, Stability, and Resilience coefficients. The 14 short-term attributes can be interpreted through the five hypothetical constructs, named factors or surrogates, reflecting the short-term performance of a mill. An attempt has also been made to develop another surrogate, reflecting the short-term performance. This surrogate is termed as Weighted Short-term Performance Surrogate (WSPS).

(4) The behavioural pattern of the sampled mills is studied for the 14 short-term performance attributes for a period of 10 years. The time-series plots on the descriptive statistics of the attributes suggest that the industry has been in somewhat of a doldrums, specifically, on account of the poor performance in terms of the following attributes (i) the rate of return before interest and depriciation (ii) networth to total assets (iii) fixed assets for equivalent spindle, (iv) wages paid as percent of sales, (v) gross profit to net sales ratio, (vi) spindle utilisation. Further, the plots confirm the suspicion of the government that there has been diversion of capital by the management into assets other than the fixed assets.

(5) The 14 short-term performance attributes which represent financial, economic, and physical efficiency of

a mill, on short-term basis, can be represented in terms of five factors F_1, F_2, F_3, F_4, and F_5. These factors identified as short-term performance surrogates account for 73.4% of the generalised variance associated with the 10- year data of the 75 sampled mills. The long-term performance of the mills is measured in terms of the surrogates, representing Risk, Stability, and Resilience coefficients. Neither the Short-term nor the long-term surrogates could classify the known cases of the 75 mills satisfactorily. Even weighted short-term performance surrogate along with the long-term performance surrogate failed on this account. The best discriminant function is corresponding to the five factors coupled with the long-term surrogates. The discriminant function comprising of these surrogates successfully classifies the known cases of mills without any discrepancy.

It is concluded that the present practice of identifying the health status of a textile mill simply based on financial norms needs to be modified. The health status should be measured in **term** of norms which reflect both the short-term and the long-term performance of a mill considering financial, economic, and physical efficiency aspects. To that effect the discriminant model enabled us establish a unitary scale for scoring the performance of an individual mill. The discriminant score when compared

with its cut-off value enables one to classify a given mill into healthy or sick group. Simultaneously, it provides the status of the mill in the comparative parlance of the discriminant scores of the other mills in the industry. The discriminant score provides an answer to the question; how sick or healthy a particular textile mill is? A knowledge on the relative health status of a mill will help the decision makers in fixing their priorities for the disbursement of scarce financial resources on the rehabilitation and nursing programmes started by the government.

(6) An analysis based on the assessment of the health status based on discriminant score for the 75 sampled mills considering the 1980-81 data suggested that the sample include 50 healthy and 25 sick mills. Further, it was observed that sickness is more prevalent in the composite mills as compared to the spinning mills. The mills bearing numbers 12, 16, 44, 20, and 33 deserve special attention by the management and the government agencies. The first four mills are marginally healthy while the remaining two are marginally sick. The marginally sick mills can be salvaged if appropriate measures are adopted. Adequate care would be required to avoid the marginally healthy mills becoming sick in future.

7.2. Scope for Future Work

Every research work has its limitations and the present research work is no exception. During the course of the present work, a need for a strong data base for the various attributes reflecting the performance of textile mills was felt. A good data base will continuously help monitor the health status of the mills through the discriminant score. The trend associated with this score, when interpreted, can provide meaningful information and can act as an early warning system.

An attempt can be made to examine the various physical productivity indices developed and adopted by ATIRA, BTRA and SITRA with a view to evolve a unitary composite physical productivity measure.

The present work can also be extended to other industrial sectors which are suffering from the prostration of sickness and have been identified in Chapter I.

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APPENDIX A

LIST OF SAMPLED MILLS AND IDENTIFICATION CODES

A four digit coding system has been developed to identify the 75 mills in the sample. The various digits of the code carry the following significance:

First digit: Indicates the zone number. The zone numbers are: 1 for Ahmedabad, 2 for Bombay, 3 for South India, 4 for Rest of North India.

Second digit: Indicates the type of mill. It carries 1, for composite mill and 2 for spinning mill.

Third and fourth digits: Indicate the serial number of the mill in the listing.

The following is the list of mills in the sample alongwith their identification code.

Sl.No.	Assigned code	Name of the mill
1.	1101	Ajit, Ahmedabad
2.	1102	Aryodya, Ahmedabad
3.	1103	Aryodya Spinning & Wvng., Ahmedabad
4.	4104	Basanti, Calcutta
5.	4105	Birla, New Delhi
6.	2106	Bombay Dyeing, Bombay
7.	4107	Cawnpore, Kanpur

8.	1108	Commercial, Ahmedabad
9.	3109	Dawangere, Bangalore
10.	3110	Dhanalakshmi, Madurai
11.	4111	Elgin, Kanpur
12.	2112	Hindustan, Bombay
13.	2113	Hukumchand, Bombay
14.	4114	Krishana, Beawar
15.	4115	MS Ummad, Rajasthan
16.	2116	Mahendra, Bombay
17.	1117	Maheshwari, Ahmedabad
18.	1118	Marsden, Ahmedabad
19.	1119	Nagri, Ahmedabad
20.	1120	Swadeshi, Ahmedabad
21.	2121	Phoenix, Ahmedabad
22.	4122	Rajkumar, Indore
23.	4123	Raza, Rampur
24.	2124	Ruby, Bombay
25.	1125	Shree Amruta, Ahmedabad
26.	1126	Shree Vivekanand, Ahmedabad
27.	**3127**	Sree Krishna Rajendra, Mysore
28.	3128	Dewan Bahadur, Hyderabad
29.	3129	Jayaram, Rajapallayam
30.	2130	Khatau, Bombay
31.	1132	New Rajpur, Ahmedabad

32.	4133	Sree Madhusudan, Calcutta
33.	4134	Sree Sajjan, Ratlam
34.	2135	Simplex, Bombay
35.	3136	Sri Venkatesh, Udumalpet.
36.	2137	Elphinston, Bombay
37.	2138	Gaekwad, Bombay
38.	2139	Lakshmi Vishnu, Bombay
39.	2140	Sree Ram, Bombay
40.	2141	Silver Cotton, Ahmedabad
41.	2142	Tata, Bombay
42.	3137	Janaki Ram, Rajapallayam
43.	3234	Yemmiganur, Kurnoul
44.	4201	Ajanta, Ghaziabad
45.	1202	Asher, Ahmedabad
46.	1203	Gandhidham, Alipur
47.	3205	Kasthuri, Coimbatore
48.	3206	Premier, Coimbatore
49.	2207	Raghuvanshi, Bombay
50.	3208	Rajalakshmi, Coimbatore
51.	3209	Sree Rajendra, Salem
52.	3210	Sri Ramnarayan, Coimbatore
53.	4211	Sutlej, Bhiwani
54.	3212	Vijay, Vijaywada
55.	3213	Vijaylakshmi, Coimbatore
56.	2214	Arunodoya, Bombay

57.	3215	Coimbatore Pioneer, Coimbatore
58.	3216	Jawahar, Salem
59.	2217	Mahalakshmi, Bombay
60.	2218	Nimar, Bombay
61.	4219	Rajasthan, Bhilwara
62.	3220	Rayalseema, Kurnool
63.	3221	Sri Sivakami, Madurai
64.	3222	Sri Kannapiran, Coimbatore
65.	3223	Sri Karunambikai, Coimbatore
66.	3224	Trichinopoly, Tiruchirapally
67.	3225	Vijayshree, Pollachi
68.	2226	Dawn, Bombay
69.	4227	Hada, Calcutta
70.	4228	Madan, Meerut
71.	3229	Rajapallayam, Rajapallayam
72.	1230	Rajprakas, Cambay
73.	3231	Sree Ganesar, Dawangere
74.	4232	Super, Hindupur
75.	4233	Usha, Badarpur

APPENDIX B

CONTROL STATEMENTS FOR SPSS

B.1 FACTOR Subroutine

RUN NAME	FACTOR ANALYSIS OF $TY1$ & $TY2$ COMBINED
FILE NAME	DUMMY
VARIABLE LIST	SRL, $CD1$ TO $CD3$, $X1$ to $X14$
INPUT MEDIUM	CARD
INPUT FORMAT	FREEFIELD
N OF CASES	759
MISSING VALUE	X_1 TO $X_3(0)$ /X_4 TO $X_6(0)$ /X_7 TO $X_9(0)$ / X_{10} TO $X_{12}(0)$ /X_{13} TO $X_{14}(0)$ /
FACTOR	VARIABLES = $X1$ TO $X14$/ TYPE = PA2/ROTATE = VARIMAX/FACSCORE/
OPTIONS	2, 5, 6, 7, 8, 9, 10, 11
STATISTICS	ALL

B.2 REGRESSION Subroutine

RUN NAME	REGRESSION OF STABILITY VS. RISK DATA OF 75 MILLS
FILE NAME	DUMMY
VARIABLE LIST	SRL, FF, RSK, STB, RES
N OF CASES	75
INPUT FORMAT	FREEFIELD
COMPUTE	LIST B = LG10 (STB)
COMPUTE	LRSK = LG10 (RSK)

VAR LABELS SRL, SERIAL NUMBER OF MILL/
FF, SEIGHTED FACTOR SCORE SUM/
RSK, RISK COEFFICIENT/
STB, STABILITY COEFFICIENT/
RES, RESILIENCE COEFFICIENT/
LSTB, LOG STABILITY/
LRSK, LOG RISK/

MISSING VALUES FF (9.99)

REGRESSION VARIABLES = FF, RSK, STB, LSTB, LRSK/
REGRESSION = LSTB WITH LRSK/

OPTIONS 2, 8, 9, 11, 12

STATISTICS ALL

B.3 DISCRIMINANT Subroutine

RUN NAME DISCRIMINANT ANALYSIS OF FINAL SCORES.

FILE NAME DUMMY

VARIABLE LIST TY, ST, F1 TO F5, SM, RSK, STB, RES/

N OF CASES 17

INPUT MEDIUM CARD

INPUT FORMAT FREEFIELD

VAR LABELS TY, TYPE OF MILL COMPOSITE OR SPINNING/
ST, STATUS OF MILL HEALTHY OR SICK/
F1, FACTOR 1 SCORE/
F2, FACTOR 2 SCORE/
F3, FACTOR 3 SCORE/
F4, FACTOR 4 SCORE/
F5, FACTOR 5 SCORE/
SM, COMPST. FACTOR SCORES/
RSK, RISK COEFFICIENT/
STB, STABILITY COEFFICIENT/
RES, RESILIENCE COEFFICIENT/

MISSING VALUES F1 TO F3 (0)/F4, F5, SM(0)/RSK, STB, RES (0)/

DISCRIMINANT   GROUPS-ST(1,2)/VARIABLES = F1 TO F5,
SM, RSK, STB, RES/
ANALYSIS = F1 TO F5, SM, RSK, STB, RES/
METHOD = DIRECT/

OPTIONS   2, 3, 4, 5, 6, 11, 12

STATISTICS   ALL

APPENDIX C

BRIEF CASE HISTORY OF 7 KNOWN SICK MILLS

Sl.No.	Mill code	Title	Case History
2	1102	Aryodya, Ahmedabad	(1) Bad debt equity rat (2) High input casts, (3) Labour Problems (4) Sensitive to cotton price. (5) High fluctuations in the rate of return; no divident. (6) Declared sick.
4	4104	Basanti, Calcutta	(1) Bad debt equity rat (2) High input costs (3) Labour problems. (4) Sensitive to cotton price. (5) No divident paid. (6) Declared sick.
8	1108	Commercial, Ahmedabad	(1) Bad debt equity rat (2) Low utilion efficien (3) Heavy losses. (4) No dividend (5) Declared sick.
14	4114	Krishna, Bewar	(1) Bad debt equity rat (2) Reported frequent l (3) No dividend paid (4) Declared sick.
21	2218	Nimar, Bombay	(1) Extremely bad debt equity ratio (2) Operationaly unecon (3) Frequent labour pro (4) Heavy losses. (5) No dividend paid (6) Declared sick.
28	3128	Dewan Bahadur, Hyderabad	(1) High operating costs (2) Low utilization ratio (3) Paid dividend (4) Reported loss. (5) Declared sick.

37	2139	Lakshmi Vishnu, Bombay	(1) Bad debt equity ratios
			(2) Operationally un-economic
			(3) Labour problems
			(4) Reported heavy loss
			(5) Declared sick.